

# PHARMACOPEDIA

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White & Humphrey







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# Pharmacopedia

*A Commentary on the British Pharmacopœia, 1898*

By

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and

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*ILLUSTRATED WITH FORTY-SIX PLATES*

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*"The best sign of originality lies in taking up a subject and then developing it so fully as to make every one confess that he would hardly have found so much in it."*—GOETHE.

*"The knowledge I have looked for was a real, precise, thorough, and practical knowledge of fundamentals; whereas that which the best of the candidates, in a large proportion of cases, have had to give me was a large, extensive, and inaccurate knowledge of superstructure."*—HUXLEY.





## Preface.

THOUGH a period of eight years has elapsed since the publication of the first edition of this book, the British Pharmacopœia of 1898—which it was intended to supplement, as a commentary—still remains the official standard and guide whereby the nature and composition of substances to be used in medicine may be ascertained and determined, and there appears to be no immediate prospect of the work being replaced by a new pharmacopœia. Meanwhile, the demand for this commentary—which was re-issued in 1904 without alteration of the text—has continued unabated, and the opportunity has now been taken to produce a revised and fully corrected edition, in which important additions are made to monographs on substances which have been the subject of recent investigation. Several of the monographs have been entirely re-written, and advantage has also been taken of the numerous valuable suggestions which have been received from correspondents who have taken a personal interest in the improvement of the book to make it of even greater value than formerly as a work of reference for practising pharmacists and students, chief among the additions thus suggested being that of the official doses for the different medicaments. Further, all the corrections formerly included in supplementary pages have been incorporated in the text, together with others which have been suggested as desirable since the re-issue of the work in an unaltered form in 1904. The thanks of the authors are now formally tendered to the many correspondents in all parts of the British Empire who have rendered valuable assistance by notifying the detection of errors and omissions, as well as to those, already referred to, who have taken such a keen personal interest in the success and improvement of the volume. With regard to the idea—to which reference was made in the preface to the first edition of this work—of issuing a supplementary volume in which non-official substances used in medicine should be dealt with on similar lines to the official medicaments, it is now felt that the publication of the British Pharmaceutical Codex, in which all important non-official medicaments are fully treated, has rendered such a supplementary volume unnecessary. The plan of the Codex was largely based upon that of 'Pharmacopœia,' the authors of which gladly placed the text of their book at the service of the compilers of the more important work, and were willing—if such a course had seemed desirable—to permit the entire absorption of the results of their labours in the Pharmaceutical Society's imperial dispensatory. Considerations of space, however, rendered it impracticable to include in the Codex such detailed explanations as constitute a special feature of 'Pharmacopœia,' and the continued existence of a work which is a commentary on the British Pharmacopœia, pure and simple, appeared to be amply demonstrated. No further apology for the re-publication of their book appears to the authors to be necessary, and they therefore submit this second edition of 'Pharmacopœia' for the same critical and kindly consideration as has been bestowed upon its predecessor.

LONDON, *October 1st, 1909.*



# Introduction.

THE art of imparting instruction or conveying information about drugs—using that term in its widest sense, as including all medicinal substances of vegetable, animal, or mineral origin—may fitly be termed “pharmacopedy,” and the intention of the authors of this book is, therefore, exactly expressed by the title of the work, the name ‘Pharmacopedia’—derived from *φάρμακον* and *παιδεία*—meaning simply instruction or information about drugs. At the same time, it has been felt desirable, on account of the very large number of substances used in medicine, to restrict the scope of the work—for the present, at least—to the official *materia medica*; it should be understood, therefore, that the primary object of the authors has been to put recorded facts together in such a way as to render the subject-matter of the British Pharmacopœia more intelligible to pharmacists and others who have occasion to consult that work. It seems imperative that pharmacists, in particular, should fully comprehend the contents of a book designed to serve as a “uniform standard and guide, whereby the nature and composition of substances to be used in medicine may be ascertained and determined,” but it may fairly be questioned whether sufficient facilities for enabling them to attain such full comprehension of the national medicine book have heretofore been generally available. In this work, however, the official descriptions of drugs are amplified and the tests explained in such a manner that it is believed much assistance will be afforded to pharmacists and all other persons to whom those descriptions and tests are of importance.

Though the explanations given are such as may readily be understood by students, no attempt has been made to supersede collateral works on botany, chemistry, or pharmacognosy. Inasmuch, however, as the ordinary text-books do not contain sufficient detailed information on many points which are dealt with in a highly-specialised work like the Pharmacopœia, an endeavour has been made to enable students to comprehend the technical details of the official monographs, by reference to the elementary principles laid down in those text-books, as it is believed that opportunities will thus be afforded of securing a better grasp of the subjects which pharmacists and medical practitioners are called upon to study. Thus, while the botany, chemistry, and pharmacognosy of the Pharmacopœia have been so explained as to reduce to a minimum the labour of reference in regard to matters of detail, the increased use of recognised text-books is likely to be encouraged rather than the reverse. As a further aid to a full comprehension of the official descriptions, a large number of illustrations of crude drugs and microscopical sections have been included in



the 'Pharmacopædic Atlas' at the end of this volume, since the authors regard the use of accurate illustrations as a necessity in the practical study of pharmacopædics, and have felt it incumbent upon them to supplement their work by a series of the best drawings available. Moreover, in view of the fact that no generally satisfactory work on modern pharmacy is at present available, particular attention has been devoted to the pharmacy of the British Pharmacopœia, the various galenicals having been considered group by group, whilst individual preparations have been the subject of special consideration in cases where such a course appeared desirable.

Only general acknowledgment can be given to the numerous works which have been freely utilised in the search for information, but special reference must be made to *The Pharmaceutical Journal and Pharmacist*, a close acquaintance with which is essential to all who may be desirous of further extending their knowledge of drugs. It has, of course, been necessary, for the purposes of this volume, to present much information in a very condensed form. At the same time, it has been found possible to explain many difficult points. In every instance care has been taken to present consistent rather than conflicting views, and, in particular, an attempt has been made to bring the chemistry of drugs as far as possible up to date, though the increase of knowledge in that direction is nowadays so rapid that deficiencies may be apparent in places. In anticipation of possible criticism, it may also be stated that references to particular investigations have been omitted, as they would have increased the size of the book far beyond the limits considered desirable; such references will be found in standard works of reference, such as the 'Year Book of Pharmacy' and the 'Proceedings of the American Pharmaceutical Association,' as well as in the leading journals of pharmacy and chemistry.

The appendixes to the British Pharmacopœia have not been dealt with in the same manner as the official monographs, because they do not lend themselves to similar treatment. The subject-matter of the first six is fully and satisfactorily treated in text-books and works of reference which are generally available. As regards weights and measures (Appendix 7), it will be observed that the denominations of the metric system have been used almost exclusively throughout the present work, but tables for the conversion of metric into imperial weights and measures, or *vice versa*, will be found in an appendix to this volume. Full descriptions of the processes of maceration and percolation, as applied in the preparation of tinctures (Appendix 8), and notes on the bases for the preparation of lozenges (Appendix 9), will be found in the monographs dealing with the groups of preparations mentioned. Finally, the list of alternative preparations sanctioned for use in India and the Colonies (Appendix 11) is dealt with in the notes on the Indian and Colonial Addendum (1900) to the British Pharmacopœia, 1898.



## Advice to Students.

FOR the sake of students using this work, it appears desirable to point out that the British Pharmacopœia is not a text-book, though it is essential that they should be more familiar with its contents than with those of any other work. But it is not sufficient, or always necessary, that the statements contained in the book should be committed to memory; they must be studied with a due sense of the reasons for so doing, frequent reference to text-books of chemistry, physics, botany, and pharmacognosy, being required in order to secure a thorough grasp of the import of the official statements. Whilst, therefore, the study of the Pharmacopœia cannot be entered upon too early in the pharmaceutical or medical student's career, he must, sooner or later, take up the study of the subjects mentioned, in order to master all the details of the national medicine book, and the student who desires to make the utmost use of 'Pharmacopœia' as a guide must possess a fair elementary knowledge, at least, of the general principles of chemistry, physics and botany.

It may not be amiss to point out that it is altogether incorrect to assume that the study of the British Pharmacopœia for examination purposes is a stupendous and unnecessary labour imposed upon students by exacting boards of examiners. So far as regards the qualifying examination conducted by the Pharmaceutical Society of Great Britain, a careful inspection of the examination syllabus will show that the memory work insisted upon is limited to a knowledge of the proportion of active constituent in the preparations of a small number of potent, and in most cases poisonous, drugs. Yet it is no uncommon thing for students to plod through the Pharmacopœia from A to Z, endeavouring to commit to memory the proportional composition of every preparation contained in it—a herculean task which no boards of examiners expect or desire candidates to attempt. It cannot be too strongly emphasised that it is both unnecessary and injurious to commit to memory the proportion of such things as cardamoms, coriander, and saffron, in the various preparations into which they enter; it is unnecessary, because the Pharmacopœia is essentially a standard book of reference and, as such, should always be consulted in any actual manufacturing operation; it is injurious, because the mind is thus burdened with trivial and useless details. The object, therefore, which students should clearly set before them in studying the Pharmacopœia is the acquisition of such knowledge as will make them skilful and safe dispensers, and not a mere parrot-like acquaintance with various formulæ. At the same time, they must not neglect to become perfectly familiar



with the proportions of active constituents in the preparations of potent drugs, since no one can be a safe dispenser without that knowledge.

In the following pages, the details of the Pharmacopœia have been dealt with in a manner which experience has proved to be the best to follow in dealing with a work of such extended range. The articles mentioned in the Pharmacopœia are considered in alphabetical order, care being taken to expand and explain the statements in each monograph, whilst endeavours are also made to use such explanations as illustrations of the principles involved. It is hoped that students will thus be assisted in the acquirement of the habit of applying their knowledge, intelligently and usefully, to the elucidation of problems of allied nature. The explanations offered are very full in most cases, and students are advised not to rest content with anything less than the ability to explain every statement made in the Pharmacopœia. In the case of the chemistry of that work, numerous instances occur in which the knowledge involved extends considerably beyond what is usually contained in the text-books used by pharmaceutical and medical students. Such information is here supplied, and the chemistry of drugs is also dealt with in a manner which, it is believed, will be found more satisfactory than is usually the case. Students are warned, however, not to rest content with knowing what are the chief constituents of drugs; they should also learn as much as possible about their composition, properties, and analogies with similar substances found in the same or other drugs.

On the botanical side, it is chiefly of importance to say that the exact significance of all technical terms employed in the Pharmacopœia should be ascertained by reference to a suitable glossary. Crude vegetable drugs should be studied in a practical manner, each drug being carefully compared with its illustration in the 'Pharmacopœdic Atlas,' and with the printed description, differences being noted when they exist, and explanations of those differences sought. A good plan for impressing upon the memory the chief features of crude drugs of vegetable origin is to make careful sketches of them, dried flowers and leaves being previously soaked in water to expand them, Transverse sections should also be prepared and sketched, on an enlarged scale if necessary. Further, it should be borne in mind that there is a very close connection between botany and pharmacognosy, and that careful study of the morphology and anatomy of vegetable drugs is required in order to obtain a thorough grasp of their structure. A pocket lens should be used freely in this connection, and a microscope when necessary.

The pharmacy of the Pharmacopœia is the subject of special treatment in the following pages. Students should deal practically with this subject also, endeavouring to make as many as possible of the official preparations, and paying particular attention to their general composition and physical properties, as well as to their behaviour with substances with which they are commonly prescribed. Extended knowledge in this direction cannot be obtained properly by mere reading; it can only be usefully and permanently acquired by practical work. Students should acquire as much detailed information as they can in that



manner—the more the better—and in their reading devote their attention to the principles of processes. To give a concrete example, the student who knows why water acidulated with hydrochloric acid is used in making liquid extract of cinchona is in possession of much more valuable information than the one who knows that he must use five fluid drachms of hydrochloric acid in the official formula, but does not know why it is employed. The pharmacy of the Pharmacopœia, approached in this way, no longer possesses the terrors which it often has had for the student labouring under misapprehension as to the information he is expected by examiners to possess, and the result is infinitely superior in every way to that which follows the acquirement of a more or less useless store of information by mere reading and effort of memory. Further, it may be pointed out that students will best obtain a useful comprehension of large groups of galenical preparations, such as the tinctures, by tabulating them for themselves, instead of merely scanning tables to be found in books. The members of the groups should be arranged in tables based upon (*a*) the proportions of active ingredients, (*b*) the nature or strength of the menstrua, (*c*) the methods of preparation, and (*d*), lastly, the doses. Such tabulation necessitates a critical consideration of each individual preparation, and that brings into prominence many points which are, otherwise, easily overlooked.

Text-books suitable for students of pharmacy are numerous, but it is advisable, at the outset, to purchase only the latest editions of a few specially selected works, which may form the nucleus of a useful scientific and technical library. Thus, a student possessing a fair elementary knowledge of the general principles of chemistry, physics, and botany, may study with advantage Newth's 'Inorganic Chemistry' (Longmans, 6s. 6d.); Perkin and Kipping's 'Organic Chemistry' (Chambers, 7s. 6d.); Briggs' 'General Elementary Science' (Clive, 3s. 6d.); Aldous' 'Elementary Course of Physics' (Macmillan, 7s. 6d.); Humphrey's 'Materia Medica and Pharmacy' (Kimpton, 6s. 6d.); and Farmer's 'Introduction to the Study of Botany' (Longmans, 2s. 6d.). Other works, including the British Pharmaceutical Codex, may be added to this list as required. The British Pharmacopœia itself must, of course, be at hand for constant reference, and students are advised to devote particular attention to the preface of that work, in order that they may be able to obtain a more thorough comprehension of the scope of the book than would otherwise be possible. In conclusion, students are urged to rid their minds of much fiction about examiners and examinations, that passes for fact, and to endeavour to realise that, in the words of the late Professor Huxley, the knowledge examiners look for is "a real, precise, thorough, and practical knowledge of fundamentals," whereas, that possessed by the best candidates, in a large proportion of cases, is "a large, extensive, and inaccurate knowledge of superstructure."



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# PHARMACOPEDIA

## Acaciæ Gummi.

**Gum Acacia** or **Gum Arabic** is a dried exudation from the stem and branches of various species of *Acacia* (N.O. Leguminosæ), the chief source of the gum being *Acacia Senegal*, Willdenow, a small tree which rarely exceeds 6 metres in height, and grows freely in various parts of Africa, more especially in the Upper Nile districts and Senegambia, but also probably in Central Africa. The gum is a degradation product, apparently resulting from the hydrolysis of cellulose by an enzyme which causes the cell-walls of the cortex and pericycle to swell and, ultimately, dissolve, the gum thus produced filling the lacunæ formed by the destruction of the cells. It tends to exude spontaneously from the stems and branches, but the outflow may be promoted by the attacks of ants or other insects, and the best gum is produced near Kordofan by removing strips of bark from the stems and branches of specially cultivated trees. The exuded gum is allowed to harden by exposure, then detached from the stems and branches, and collected in baskets, that collected in the Kordofan district being conveyed to Omdurman, whence it is exported to Trieste, where it is graded for the market. East Indian or Bombay gum is also produced in Eastern Africa, but reaches London *via* Bombay. Senegal gum, from *A. Senegal*, is exported from St. Louis, Senegambia; the best qualities closely resemble Kordofan gum, and are suitable for pharmaceutical purposes. Mogadore gum, from *A. gummifera*, Willdenow, is collected in Northern Africa, and is sometimes indistinguishable from Kordofan gum. Inferior gums are obtained from various species of *Acacia*, which grow in Southern Africa, Australia, and India.

**Characters and Tests.**—Gum acacia occurs in rounded or ovoid, opaque, white or yellowish tears or masses, the largest of which are about equal to a hazel nut in size. Their opacity is due to numerous minute external fissures. They are also very brittle, and the fragments of broken tears, which are more or less angular and quite transparent, show glistening vitreous surfaces. The gum has a very faint odour, and a bland, mucilaginous taste. It is entirely soluble in cold water, but only slightly soluble in alcohol or other liquids, unless there be a considerable quantity of water present. Thus, it is quite insoluble in 90 per cent. alcohol, and 60 per cent. alcohol only extracts from it certain of its constituents, but weaker alcohols dissolve the gum in proportion to the quantity of water they contain, 100 parts of 22 per cent. alcohol dissolving as much as 57 parts of gum. When dissolved in its own weight of water, the gum forms a translucent viscid mucilage, which feebly reddens litmus, owing to the excess of acid present in the gum. If the mucilage should be glairy or ropy, or yield a gelatinous deposit after dilution with water, the probability is that it has been prepared from an inferior African, Australian, or Indian gum, such as should not be used for pharmaceutical purposes. The tests with lead subacetate and borax serve

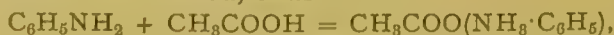


no useful purpose, and should be omitted. No precipitate should be formed when 0.2 C.c. of lead acetate solution is added to 10 C.c. of a 10 per cent. aqueous solution of gum acacia. An artificial gum has been prepared from commercial "dextrin," a mixture of varying composition, which may contain unaltered starch and be coloured by iodine accordingly, but consists largely of erythro-dextrin, which gives a reddish-brown colour with iodine, unless the reaction be obscured by the blue colour produced by a considerable proportion of soluble starch. Powdered gum acacia may be adulterated with starch or flour, both of which can be detected by means of solution of iodine, which colours starch blue in the presence of water. In applying the iodine test care should be taken that the liquids are cold, as the blue colour with starch and the brown with erythro-dextrin are not formed in hot solutions. Tannin is present in inferior gums—such as those from Australian species of *Acacia*—and can be detected by the bluish-black coloration produced on adding 0.1 C.c. of test solution of ferric chloride to 10 C.c. of an aqueous solution of gum. The test with Fehling's solution of potassio-cupric tartrate is unsatisfactory, as a 10 per cent. aqueous solution of gum acacia may give a red precipitate when boiled with the solution. As a 10 per cent. aqueous solution of gum acacia should exhibit slight lævorotation when examined in a tube 1 Dcm. long, this test should be used to exclude dextrin, certain sugars, and other dextrorotatory substances. Gum acacia should not yield more than 4 per cent. of ash, consisting almost entirely of calcium, magnesium, and potassium carbonates.

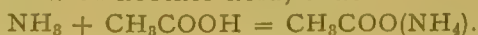
**Notes.**—The distinctive characters of gum acacia are the numerous minute external fissures which cause the opaque appearance of the tears, the vitreous appearance of fractured surfaces, the ready solubility of the gum in water, and the adhesiveness of aqueous solutions. The gum consists chiefly of di-arabinan-tetragalactan-arabic acid (arabin), combined with calcium, magnesium, and potassium, and may be regarded as being chiefly an acid calcium salt. It contains from 12 to 17 per cent. of moisture and a trace of sugar, and yields from 2.7 to 4 per cent. of ash. The acid, on hydrolysis, yields arabic (isogeddic) acid and two sugars—arabinose and galactose. Gum acacia also contains an oxydase or oxidising enzyme, which gives a blue coloration with freshly powdered guaiacum resin, or a simple tincture of the resin, diluted with water.

## Acetanilidum.

**Acetanilide**, commonly known as Antifebrin, is obtained by the interaction of aniline and glacial acetic acid. When aniline is heated with glacial acetic acid, aniline acetate is first formed, thus—



just as ammonia (from which aniline may be regarded as being derived by substitution of the phenyl radical,  $\text{C}_6\text{H}_5$ , for one hydrogen atom) forms ammonium acetate by reaction with acetate acid, thus—



By heating the aniline acetate for some hours in a flask fitted with a reflux condenser one molecule of water is eliminated and acetanilide is produced, thus—



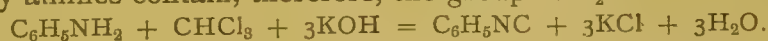


The reaction mixture is then poured into water and the precipitated acetanilide purified by recrystallisation from hot water or diluted alcohol.

**Characters and Tests.**—Acetanilide occurs in colourless, odourless, glistening lamellar crystals, having a slightly pungent taste, and melting point, when dry,  $113^{\circ}\text{C}.$ ; the melting point is considerably affected by the presence of traces of moisture. It is soluble in 200 parts of cold water or 18 parts of boiling water, in 4 parts of 90 per cent. alcohol, and freely in ether, benzol, and chloroform. When boiled with test-solution of ferric chloride a reddish-brown colour is produced, and is almost entirely discharged by hydrochloric acid, but a similar colour is produced on boiling the test-solution alone. Heated with solution of potassium hydroxide, acetanilide undergoes hydrolysis, a molecule of water being taken up. Consequently aniline and acetic acid are regenerated, the latter combining with the alkali to form potassium acetate.



By adding a few drops of chloroform and warming the mixture, phenyl isocyanide, recognisable by its nauseous odour, is produced. This reaction (Hofmann's) is characteristic of all primary amines, *i.e.*, bodies derived from ammonia by the replacement of one hydrogen atom by a group or radical. The primary amines contain, therefore, the group  $\text{NH}_2$ .



Solution of bromine produces an insoluble brom-acetanilide when added to a cold saturated aqueous solution of acetanilide. A similar reaction does not occur with phenacetin, because in the latter the hydrogen atoms remaining in the aromatic nucleus are "protected" by the presence of the ethoxy group ( $\text{O}\cdot\text{C}_2\text{H}_5$ ). Heated with free access of air acetanilide burns and leaves no residue, and when added to cold sulphuric or nitric acid it forms a colourless solution, many other organic substances being charred or giving colour reactions with those reagents. A cold saturated aqueous solution should be neutral to litmus and should be unaffected by the addition of ferric chloride, the last test distinguishing it from phenazone, salts of aniline, and many other substances which give colour reactions with ferric chloride in the cold.

**Notes.**—Hofmann's reaction only occurs in presence of free alkali, and is of interest in showing the difference between the constitution of isomeric cyanides and isocyanides. The phenyl-isocyanide produced in the reaction above probably has the nitrogen linked directly to the phenyl radical  $\text{C}_6\text{H}_5\text{—N—C}$ , on account of its production from aniline  $\text{C}_6\text{H}_5\text{—NH}_2$ , while phenyl cyanide would have the carbon directly united to the phenyl radical  $\text{C}_6\text{H}_5\text{—C—N}$ .

[Dose.—1 to 3 grains.]

## Aceta.

**Vinegars.**—The official vinegars are three in number. Acetic acid has been suggested as a menstrum for the exhaustion of many drugs, and the vinegars so prepared have been shown in many cases to possess the desired activity, owing to the solvent action of acetic acid upon nearly all proximate vegetable principles. Such preparations have also been found to possess good keeping



properties, hence acetic acid could in many cases replace the more expensive alcohol as a menstruum for galenical preparations. The vinegars must, however, be strongly acid for the manifestation of those solvent and preservative properties, and this limits the use of vinegars, because the acid may be contra-indicated medicinally and often introduces difficulties of incompatibility when the preparations are prescribed with other remedies.

**Acetum Cantharidis.** VINEGAR OF CANTHARIDES.

Made by maceration and percolation of 1 part of bruised cantharides so as to produce 10 fluid parts of percolate with a menstruum of equal parts water and glacial acetic acid. A better preparation is made direct from cantharidin.

**Acetum Ipecacuanhæ.** VINEGAR OF IPECACUANHA.

This is a dilution of 1 part of the liquid extract of ipecacuanha with 2 parts of 90 per cent. alcohol and 17 of diluted acetic acid. The vinegar should, therefore, contain 0.1 to 0.1125 part of ipecacuanha alkaloids in 100 fluid parts, the alcohol being added to ensure their preservation.

[Dose.—10 to 30 minims.

**Acetum Scillæ.** VINEGAR OF SQUILL.

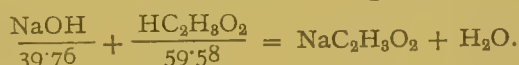
Made by macerating 1 part of bruised squill in 8 parts of diluted acetic acid, but it would be better if the product were made up to a definite volume.

[Dose.—10 to 30 minims.

## Acidum Aceticum.

**Acetic Acid** is one of a large number of substances of great importance in chemistry and pharmacy produced, by the destructive distillation of wood. In addition to a residue of carbon and the mineral substances constituting the ash, a distillate is obtained which is broadly divisible into three fractions: (1) gas which escapes condensation and consists chiefly of carbon monoxide, carbon dioxide, hydrogen, and methane, (2) an acid aqueous liquid (pyroligneous acid), and (3) tar. Fraction (3) is the source of creosote. Fraction (2), after separation of the tar, is neutralised with lime and redistilled. The lime fixes the acids, which consist chiefly of acetic acid and some of its homologues, while the distillate after rectification is known as wood-spirit or wood-naphtha. The residue of this distillation is then evaporated and consists chiefly of impure calcium acetate. It is heated cautiously to drive off empyreumatic substances and then distilled with hydrochloric acid. The distillate is fairly pure acetic acid. The other source of acetic acid—the oxidation of ethylic alcohol—is of importance only in the production of vinegar, a liquid which consists essentially of a dilute solution of acetic acid, coloured and flavoured by the substances which accompany the ethylic alcohol in the alcoholic fluid subjected to oxidation. The two chief varieties are malt vinegar from beer, and wine vinegar from white or red wine. The oxidation of the ethylic alcohol to acetic acid is accomplished by the ferment organism *Mycoderma aceti*, the oxygen being derived from the atmosphere. The official Acidum Aceticum should contain 33 per cent. of real acetic acid.

**Characters and Tests.**—Acetic acid is a clear colourless liquid with a pungent odour, affording when neutralised with alkali the reactions characteristic of acetates. Specific gravity, 1.044. Each gramme should require for neutralisation 5.5 C.c. of normal sodium hydroxide solution. In titrating acetic acid the best indicator is phenol-phthalein. Litmus cannot be used because an aqueous solution of sodium acetate is alkaline to this indicator, and therefore a blue colour is produced before the whole of the acetic acid is neutralised. Each C.c. of normal sodium hydroxide solution indicates 0.05958 gramme of acetic acid in accordance with the equation:—



The 5.5 C.c. of soda solution in the official test indicate therefore  $0.05958 \times 5.5 = 0.32769$  gramme of actual acetic acid in 1 gramme of Acidum Aceticum, or 32.769 per cent. It should leave no residue on evaporation, and should be free from lead, copper, arsenium, chlorides, nitrates, sulphates, and sulphites. It should not darken in colour when neutralised with ammonia and warmed with solution of silver nitrate. Any darkening effect in this test would indicate the presence of formic acid, which reduces silver nitrate to metallic silver. Formic acid is produced as well as other homologues of acetic acid in the destructive distillation of wood, but it should be removed during the purification of the crude pyroligneous acid. If 2 C.c. of acetic acid be diluted with 10 C.c. of water it should not immediately discharge the colour of one drop of solution of potassium permanganate, showing absence of more than traces of empyreumatic substances. This test is based upon the fact that the organic substances comprised under the term empyreumatic or tarry substances reduce the permanganate, and consequently destroy the crimson colour of the solution, while acetic acid itself is not oxidised by that body in the cold. Inspection of the constitutional formula for acetic acid,  $\text{CH}_3\text{COOH}$ , readily shows why it is not easily oxidised, for the carbon atom in the carboxyl group is already fully oxidised and the other carbon atom exists as a paraffin residue,  $\text{CH}_3$ , and it is well known that such alkyl groups are only oxidised with difficulty.

**Notes.**—In applying the reactions for acetates to acetic acid remember that the acid must be neutralised with an alkali before adding ferric chloride to produce the characteristic red colour of ferric acetate. Ferric acetate is decomposed by acids—hence the red colour is discharged when hydrochloric acid is added, and is therefore not produced in solutions already acid. When the red ferric acetate solution is boiled, a brownish red precipitate of ferric oxyacetate is produced, which, after subsidence, leaves a clear supernatant fluid. The exact composition of this oxyacetate depends upon the proportion of the reacting substances, the dilution of the solution, and other conditions of the experiment. The following equation is typical of the reaction which always results in the liberation of some acetic acid,



This reaction is utilised for the separation of iron from certain other metals which do not similarly form an insoluble oxyacetate under these conditions.



## Acidum Aceticum Dilutum.

**Diluted Acetic Acid** is obtained by diluting stronger acetic acids with water so that the resulting product contains 4·27 per cent. of real acetic acid.

**Characters and Tests.**—Diluted acetic acid is of specific gravity 1·006. Each gramme should require 7·1 C.c. of decinormal sodium hydroxide solution for neutralisation. As this is a very dilute solution of acetic acid, it is best titrated with decinormal alkali, which is obtained by diluting the normal soda solution to ten times its bulk with distilled water.

**Notes.**—The object of using the decinormal solution is to diminish the error of observation in reading the burette and producing the end reaction. Each 1 C.c. of the decinormal solution will neutralise 0·005958 gramme of  $\text{HC}_2\text{H}_3\text{O}_2$ ; therefore 7·1 C.c. indicate  $7·1 \times 0·005958 = 0·0423$  gramme of acetic acid in 1 gramme of Acidum Aceticum Dilutum, or 4·23 per cent.

[Dose.— $\frac{1}{2}$  to 2 fluid drachms.

## Acidum Aceticum Glaciale.

**Glacial Acetic Acid** is obtained by the distillation of dried sodium or calcium acetate with strong sulphuric acid. Under those conditions the distillate is almost free from water, and should contain at least 99 per cent. of real acetic acid.

**Characters and Tests.**—Glacial acetic acid, at summer temperatures, is a clear, colourless liquid with a very pungent odour. When cooled it solidifies to a crystalline mass and remains crystalline until the temperature rises above  $15·5^\circ \text{C}$ ., when it again liquefies if it contains 99·5 per cent. of acetic acid; if, however, it contains the minimum amount allowed by the official titration test it will liquefy at  $14·8^\circ \text{C}$ . When neutralised it affords the reactions characteristic of acetates (*vide* notes on Acidum Aceticum). Its specific gravity is 1·058, and that is increased by the addition of 10 per cent. of water. The increase of specific gravity by the addition of water is progressive until the mixture contains 77 per cent. acid and 23 per cent. water. This proportion corresponds to the formation of the hydrate,  $\text{CH}_3\text{COOH}$ ,  $\text{H}_2\text{O}$  (or perhaps  $\text{CH}_3\text{C}(\text{OH})_3$ , *i.e.*, ortho-acetic acid), and the fluid has a specific gravity of 1·075. If the dilution be continued, the specific gravity falls from that point, and when the mixture contains 46 per cent. acetic acid the specific gravity is 1·058, or the same as that of the original glacial acetic acid. By the further addition of water to this 46 per cent. acid the specific gravity continues to fall, whereas the nearly absolute glacial acid of the same specific gravity shows an increased specific gravity by the first addition of water. Each gramme of glacial acetic acid should require for neutralisation 16·6 C.c. of normal sodium hydroxide solution, because 1 C.c. of that solution (*vide* Acidum Aceticum) neutralises 0·05958 gramme of  $\text{HC}_2\text{H}_3\text{O}_2$  and  $0·05958 \times 16·6 = 0·989$ , while 0·989 gramme in 1 gramme = 98·9 per cent.

**Notes.**—On account of its solvent action on many bodies glacial acetic acid may be used for their purification by solution and recrystallisation, and it is therefore an exceedingly valuable substance in organic chemistry. As

already mentioned under Acidum Aceticum, it is not easily affected by oxidising agents; it therefore serves as a medium for subjecting numerous bodies, which are soluble in it, to the action of energetic oxidising agents, such as chromic acid.

## Acidum Arseniosum.

**Arsenious Acid**, or, more correctly, Arsenious Anhydride, is commonly known as Arsenic, or White Arsenic. It is obtained by roasting certain arsenical ores, the arsenium in those ores combining with the oxygen of the air to form the readily volatile arsenious anhydride, which sublimes and is collected in flues in the form of "meal." This meal by resublimation is converted into compact masses which are at first glassy and amorphous, but on keeping become porcelain-like through crystallisation. The formula,  $\text{As}_4\text{O}_6$ , is employed in place of the simpler formula,  $\text{As}_2\text{O}_3$ , in accordance with the result of vapour density determinations, but the formula  $\text{As}_2\text{O}_3$  is often employed, as below, for the sake of simplicity.

**Characters and Tests.**—Arsenious acid occurs as a heavy white powder, or in masses or lumps showing stratification, owing to the presence of alternate layers of the two modifications, amorphous and crystalline, referred to above. It is soluble, on long standing, in about 100 parts of cold water; in 10 parts of boiling water, the greater part being deposited on cooling; and in 5 parts of glycerin. The figures given for the solubility of this substance are, however, contradictory, and the solubility of the two modifications appears to vary considerably. It is more soluble in acid and alkaline liquids. Its aqueous solution is colourless and tasteless, and has a faint acid reaction. This is due to the formation of arsenious acid by combination with water, thus—



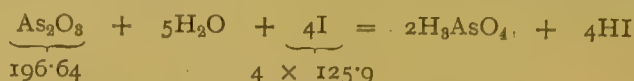
When silver nitrate is added to this aqueous solution—without addition of acid or alkali—silver arsenite is produced, but only partly precipitated, because it is soluble in the nitric acid simultaneously produced, thus—



The test is, therefore, rendered more delicate by using the solution of silver ammonio-nitrate, since the nitric acid is hereby neutralised and the silver arsenite precipitated. Silver arsenite is also soluble in excess of ammonia, whereas silver iodide, which is also yellow, is insoluble in both nitric acid and ammonia. Sprinkled on ignited charcoal, the anhydride emits an alliaceous odour. It volatilises at about  $205^\circ\text{C}$ . The purity of arsenious anhydride is determined by titration with iodine solution, and the calculation is based upon the conversion of the arsenious into arsenic acid by the indirect oxidising action of the iodine. 0.25 gramme of arsenious anhydride dissolved quickly in boiling water with 1.25 gramme of sodium bicarbonate should, after the cooled solution is well shaken with three successive drops of hydrochloric acid, discharge the colour of 50.8 to 50.9 C.c. of N/10 solution of iodine. In this operation solution of the anhydride is facilitated by the use of the bicarbonate,



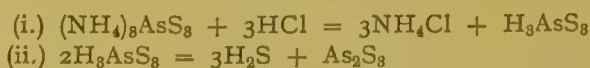
some of which is, however, converted into normal carbonate during ebullition. The equation as written thus—



is an example of a reversible reaction, and is only completed if sufficient alkali be present to neutralise the arsenic and hydriodic acids, since these two free acids react to produce free iodine and arsenious acid. Alkali carbonates (and hydroxides) react with iodine, and hence sodium bicarbonate is employed to neutralise the acids, since this salt does not absorb iodine during the titration. The addition of the three drops of hydrochloric acid after solution of the arsenious anhydride is intended to remove any carbonate produced during the boiling, partly by conversion into sodium chloride and partly by reconversion into bicarbonate through the carbonic acid formed by the action of the hydrochloric acid. According to the equation given above, 195.64 grammes of arsenious anhydride ( $\frac{1}{2}\text{As}_4\text{O}_6$ ) will react with  $4 \times 125.9 = 503.6$  grammes (4I) of iodine. Now the official volumetric solution of iodine is decinormal, and therefore contains 12.59 grammes of iodine in 1 litre. Since  $12.59 = \frac{503.6}{40}$  it follows that 1 litre of this decinormal iodine solution

will be equivalent to  $\frac{196.64}{40} = 4.916$  grammes of arsenious anhydride, there-

fore each 1 C.c. of decinormal iodine solution is equivalent to 0.004916 gramme of  $\text{As}_2\text{O}_3$  and 50.8 C.c. indicate  $0.004916 \times 50.8 = 0.2497$  gramme in the 0.25 gramme of Acidum Arseniosum taken for titration, or 99.88 per cent. If starch mucilage be used as indicator, it is best to add it towards the end of the reaction when the brown colour of the iodine begins to disappear slowly and not much more iodine remains to be added. In this way one obtains a sharp end reaction with a bright blue colour, free from the blackish flocks which are produced if the starch be present from the commencement of the titration. Arsenious anhydride should be free from lead, cadmium, antimony, tin, and sulphides. It should dissolve completely in solution of ammonia, and the resulting liquid, when diluted with an equal volume of water, and rendered acid by the addition of hydrochloric acid, should have no yellow colour, showing absence of  $\text{As}_2\text{S}_3$ . If any sulphide be present in the anhydride as an impurity it dissolves in solution of ammonia, forming a thio-salt corresponding to the arsenites, *e.g.*  $(\text{NH}_4)_3\text{AsS}_3$ , in which sulphur replaces oxygen. When the solution is acidulated with hydrochloric acid, yellow arsenious sulphide is precipitated because the free acid corresponding to the thio-salt is unstable and decomposes into  $\text{H}_2\text{S}$  and  $\text{As}_2\text{S}_3$ , thus—



**Notes.**—The formation of soluble alkali thio-salts by the sulphides of arsenic, antimony, and tin, and their decomposition by means of acids, is utilised in qualitative analysis to effect the separation of those metals from the other metals precipitated along with them by sulphuretted hydrogen from acid

solutions. The volatility of arsenious anhydride and its condensation in the form of octahedral crystals furnishes a valuable test for the identification of arsenic in toxicological and other investigations. The operation should be performed on a very small quantity in a narrow test tube, the sublimate being examined by means of a powerful pocket-lens or the low power of a microscope.

[Dose.— $\frac{1}{60}$  to  $\frac{1}{15}$  grain.]

## Acidum Benzoicum.

**Benzoic Acid**,  $C_6H_5COOH$ , is obtained (1) from benzoin, (2) from toluene, and (3) from hippuric acid. Benzoic acid from all those sources is identical if chemically pure, but when prepared from benzoin it has a distinctive aromatic pleasant odour due to adherent traces of odorous substances. From benzoin it may be prepared by sublimation; or by boiling the benzoin with lime and water, which extracts the benzoic acid forming the soluble calcium benzoate. The filtrate on acidulation with hydrochloric acid lets fall a precipitate of benzoic acid which is very sparingly soluble in cold water, and requires purification by recrystallisation. Benzoic acid is obtained from toluene by oxidation. When toluene (methyl-benzene),  $C_6H_5 \cdot CH_3$ , is boiled in a flask fitted with a reflux condenser with chromic or nitric acid the methyl group is gradually oxidised to carboxyl with formation of benzoic acid,  $C_6H_5COOH$ . This occurs not only with toluene but also with other derivatives of benzene having one side chain, no matter what the composition of this side chain may be. For example, propyl benzene,  $C_6H_5-CH_2 \cdot CH_2 \cdot CH_3$ , benzaldehyde,  $C_6H_5-C \cdot O \cdot H$ , and cinnamic acid,  $C_6H_5-CH:CH \cdot COOH$ , all yield benzoic acid by oxidation, the side chain being oxidised while the aromatic nucleus remains unattacked. The latter is only oxidised by energetic oxidising agents at an elevated temperature. The direct oxidation of toluene itself is effected comparatively slowly. If, however, benzyl chloride,  $C_6H_5CH_2Cl$  (the residue— $C_6H_5 \cdot CH_2-$  is called benzyl), be first prepared the oxidation of this body can be carried out much more quickly than that of the original hydrocarbon. This method is consequently adopted commercially. To prepare the benzyl chloride boiling toluene is submitted to the action of chlorine preferably exposed to strong light. This causes substitution to occur in the side chain; if chlorination be carried out at a low temperature and in the dark the substitution takes place in the benzene nucleus, and quite another compound results, viz., chlor-toluene,  $C_6H_4Cl \cdot CH_3$ . This statement is of general application to the action of bromine and chlorine on the homologues of benzene, and should be carefully remembered, with the reservation that in actual practice a small quantity of the derivative contrary to the rule is usually obtained. In the present case a little chlor-toluene is formed at the same time as the benzyl chloride, and by the subsequent oxidation yields chlor-benzoic acid,  $C_6H_4Cl \cdot COOH$ . The fact that any chlorine remains in the oxidised product is a proof that the substitution has been partly effected in the benzene nucleus and not entirely in the side chain (*vide* test for chlor-benzoic acid). The oxidation is accomplished by boiling the chlorinated product with moderately strong nitric acid. Note carefully the effect on the oxidisa-



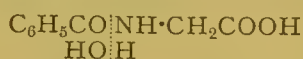
bility of the side chain produced by the entrance of the chlorine atom in benzyl chloride. The entrance of various elements and groups often profoundly modifies the behaviour of the compound towards reagents, and this point is frequently utilised in synthetical processes. In the urine of herbivorous animals, such as the ox and horse, hippuric acid is found in place of the uric acid of the urine of carnivorous animals. Hippuric acid is benzoyl-amido-acetic acid, thus—

Acetic acid,  $\text{CH}_3\cdot\text{COOH}$ .

Amido-acetic acid,  $\text{NH}_2\cdot\text{CH}_2\cdot\text{COOH}$ .

Benzoyl-amido-acetic acid,  $\text{C}_6\text{H}_5\text{CO}\cdot\text{NH}\cdot\text{CH}_2\cdot\text{COOH}$ .

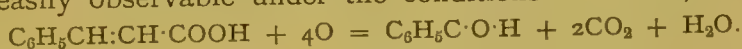
When hippuric acid is boiled with dilute hydrochloric acid hydrolysis occurs, with formation of benzoic and amido-acetic acids, thus—



As a point in nomenclature note that the benzoyl radical,  $\text{C}_6\text{H}_5\text{CO}$ , bears the same relationship to benzoic acid as acetyl ( $\text{CH}_3\text{CO}$ ) to acetic acid. When the hydrolysis is completed the benzoic acid can be filtered off, leaving the amido-acetic acid in solution as hydrochloride. Amido-acetic acid or glycocoll, as it is called (because it has a sweet taste and was originally obtained from colloid substances like gelatin), is an example of a body which is capable of acting as a base by virtue of its ammonia residue, or as an acid, because it contains replaceable hydrogen in a carboxyl group. Benzoic acid from hippuric acid, unless very carefully purified, has an unpleasant odour indicative of its origin. It is probably sometimes mixed with some benzoic acid from benzoin in order to cover this odour.

**Characters and Tests.**—Benzoic acid forms light feathery crystals, which are flexible, nearly colourless, and odourless when quite pure, the acid from benzoin having an aromatic odour, as already explained. The acid is soluble in 400 parts of cold and in 17 parts boiling water, in 1 part of absolute alcohol, in 3 parts of 90 per cent. alcohol, in 2.5 of ether, in 7 of chloroform, and in fixed and volatile oils. Aqueous solutions of the alkalis dissolve benzoic acid forming soluble benzoates, and these solutions yield a precipitate of benzoic acid when acidulated (unless the solutions be extremely dilute) owing to the sparing solubility of free benzoic acid in water. When an aqueous solution of benzoic acid is boiled, some of the acid passes off with the steam. Melting point when pure  $121.4^\circ\text{C}$ ., but the acid from benzoin melts slightly below that temperature ( $120^\circ\text{C}$ .), owing to the presence of traces of other substances associated with it. If the application of heat be carefully continued, the liquefied benzoic acid boils at about  $240^\circ\text{C}$ . Its vapour is inflammable, and during the liquefaction the colour of the product should be only yellow to brown; any organic impurities which are not volatile remain behind and char, while if hippuric acid be present a red colour will be produced by its decomposition products. If 0.5 gramme of benzoic acid be mixed and ignited with twice its weight of calcium carbonate (which must be free from chloride), the residue dissolved in diluted nitric acid and solution of silver nitrate added, only the slightest cloudiness, at most, should be

produced, showing absence of more than traces of chlorbenzoic acid. If any chlor-benzoic acid be present, it will be decomposed by ignition with calcium carbonate, a proportionate quantity of calcium chloride being formed. The diluted nitric acid will convert the excess of calcium carbonate into calcium nitrate, and at the same time dissolve any calcium chloride which may have been formed and will be detected by the formation of a precipitate of silver chloride on the addition of silver nitrate solution. Benzoic acid should be free from oxalic acid or oxalates. When warmed with its own weight of potassium permanganate and ten times its weight of diluted sulphuric acid, no odour of benzaldehyde (bitter-almond oil) should be developed, showing absence of cinnamic acid, which is sometimes present in benzoic acid derived from Sumatra benzoin. This test depends upon the oxidation of the side chain in cinnamic acid; when fully oxidised, cinnamic acid yields benzoic acid, but the intermediate stage of oxidation to benzoic aldehyde is easily observable under the conditions described, thus—



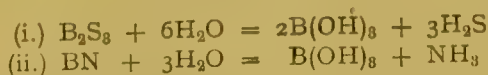
If 0.2 gramme of benzoic acid be suspended in 10 C.c. of water, it should not immediately discharge the colour of two drops of solution of potassium permanganate. This test serves to detect not only hippuric and cinnamic acids but many other organic substances capable of reducing permanganate. This reagent has no action on benzoic acid in the cold, because the side chain is fully oxidised and the benzene nucleus is very stable towards oxidising agents (compare Acidum Aceticum). Compounds like hippuric and cinnamic acids having side chains not fully oxidised are oxidised by the permanganate with consequent discharge of the pink colour of the solution.

**Notes.**—In neutral or alkaline solutions, potassium permanganate is reduced to the state of hydrated manganese dioxide  $\text{MnO}_2, x\text{H}_2\text{O}$ , which forms a brownish muddy precipitate, while in acid solution the oxidation is more energetic, and the manganese is reduced to the state of manganous oxide  $\text{MnO}$ , which in presence of an acid dissolves to form the corresponding salt, *e.g.*,  $\text{MnSO}_4$ .

[Dose.—5 to 15 grains.]

## Acidum Boricum.

**Boric Acid**, also known as Boracic Acid, is obtained by purifying native boric acid, or by the action of sulphuric or hydrochloric acid on solution of borax. Boric acid is found in the lagoons which are formed by the condensation of volcanic vapours and is believed to originate in the decomposition of boron sulphide or boron nitride by water which gains access to the heated interior of volcanic regions. The reaction between those substances and water results in the formation of boric acid and hydrogen sulphide and ammonia respectively, thus—



The chief natural deposits of borates from which boric acid is derived are the native borax of North America and Thibet and a double borate of sodium and calcium in Chili.



**Characters and Tests.**—Boric acid forms colourless, pearly, lamellar crystals, which are unctuous to the touch, slightly acid and bitter, and have a sweetish after-taste. The acid is soluble in less than 30 parts of water, and should form a clear solution; it is also soluble in 3 of boiling water, and in 30 of alcohol. Its reaction is only feebly acid and an aqueous solution gives only a wine-red colour with litmus; if, however, the solution be hot and saturated it gives a bright red colour. Turmeric paper dipped in an aqueous solution, even when faintly acidulated with hydrochloric acid, becomes brownish-red on gently drying and changes to greenish-black if potassium hydroxide be added. The cause of this peculiar action on the yellow colouring matter of turmeric does not appear to be well known. An alcoholic solution of boric acid burns with a green-tinged flame; the facility with which this effect is produced is probably due to the formation of volatile ethyl borate, the addition of sulphuric acid (which would facilitate the formation of that ester) increasing the effect. When heated, boric acid liquefies and on continued heating it loses water and finally leaves a residue of boric anhydride,  $B_2O_3$ , the loss of weight amounting to 43·6 per cent. of the boric acid, thus—

$$\begin{array}{rcccl} \underbrace{2H_3BO_3}_{122\cdot98} & = & \underbrace{3H_2O}_{53\cdot64} & + & \underbrace{B_2O_3}_{69\cdot34} \\ 122\cdot98 \text{ grammes boric acid lose } 53\cdot64 \text{ grammes of water,} \\ \therefore 1 \text{ gramme boric acid loses } \frac{53\cdot64}{122\cdot98} = 0\cdot436 \text{ gramme of water,} \\ \text{equivalent to } 43\cdot6 \text{ per cent.} \end{array}$$

The residue of boric anhydride solidifies in cooling to a brittle glassy mass. Boric acid should be free from lead or copper, and contain only traces of iron, calcium, potassium, sodium, ammonium, chlorides or sulphates.

**Notes.**—Lead and copper, if present in boric acid, would probably be derived from the utensils employed in its manufacture. It is important to ensure that this substance is free from sulphuric acid, which might be present if the precipitated boric acid had been insufficiently washed or recrystallised. Boric acid is chiefly used as a dusting powder or lotion; when pure, it is free from irritating properties, and on this account may be freely applied to wounded surfaces. [Dose.—5 to 15 grains.

## Acidum Carbolicum.

**Phenol**,  $C_6H_5OH$ , commonly known as Carbolic Acid, is obtained from coal-tar. The details of the method by which it is obtained are carefully guarded by the manufacturers, but in outline the process consists of a combination of fractional distillation with chemical treatment. By fractional distillation the tar from the gas-works is separated into several fractions, the number of which, as well as the temperature at which they are collected, varying in different factories and also at different times according to the relative market price of the numerous products derived directly or indirectly from them. Phenol and its homologues are contained chiefly in the fraction distilling a little below  $200^\circ C.$ , this fraction containing also considerable quantities of hydrocarbons. It is shaken with solution of sodium hydroxide, which withdraws the

phenol as the water-soluble sodium phenate,  $C_6H_5ONa$ , the mixture separating into an aqueous layer containing the sodium phenate and an oily hydrocarbon layer. After separating the latter, the aqueous liquid is treated with sulphuric acid which liberates the phenol from its sodium compound. The layer of impure phenol which now separates is then purified by renewed treatment with soda and by fractional distillation and crystallisation.

**Characters and Tests.**—Phenol forms small, colourless, deliquescent crystals with a characteristic odour and sharp pungent taste, having a caustic action on the skin. It is freely soluble in alcohol, ether, benzol, chloroform, carbon bisulphide, glycerin, and fixed and volatile oils. It dissolves also in caustic alkali solutions, but exists then as the water-soluble alkali phenates. Phenol becomes pink on keeping, especially if exposed to moist air, the probable cause of that being the formation of some coloured derivative from the traces of impurities always present in commercial phenol. The behaviour of phenol with water should be carefully observed; it liquefies by the addition of one-tenth its weight of water, dissolves in about 12 parts of cold water, while 10 parts of phenol dissolve 3 to 4 parts of water. If phenol and water be mixed in intermediate proportions two distinct layers are formed; one may be regarded as a solution of phenol in water, and the other, a solution of water in phenol. The aqueous solution should be colourless and clear, showing the absence of hydrocarbons and less soluble homologues of phenol. The melting-point of pure phenol is about  $42^\circ C.$ , but it is considerably lowered by the presence of traces of water and cresol, and a sample melting not lower than  $38.8^\circ C.$  is sufficiently pure for medicinal purposes. Boiling point  $182^\circ C.$ , specific gravity, at the melting-point, 1.060 to 1.066. Phenol does not immediately redden blue litmus paper, but when moistened a feeble change may be observed. It does not rotate the plane of a ray of polarised light and coagulates solution of albumen and collodion, these three tests distinguishing it from creosote, which has a contrary effect. Phenol forms a liquid when rubbed with camphor. It strikes a deep purple colour with ferric chloride and a cold aqueous solution gives upon the addition of bromine-water a white precipitate. This insoluble substance is tribrom-phenol, in which three hydrogen atoms in the aromatic nucleus are replaced by bromine, the hydrogen of the hydroxyl group being only replaced when a large excess of bromine is employed, thus—



An aqueous solution of phenol, with one-fourth its volume of solution of ammonia and a few drops of chlorinated soda solution, gives a blue colour, which appears gradually but immediately on warming. One volume of liquefied phenol (produced by the addition of 10 per cent. of water), forms with one volume of glycerin a clear fluid, which is not rendered turbid by the addition of three volumes of water; if, however, any appreciable quantity of cresol be present a turbid fluid will be formed, since cresol is much less soluble in the glycerin and water mixture.

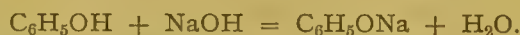
**Notes.**—As phenol is the hydroxyl derivative of the hydrocarbon benzene,



it is comparable in that respect to ordinary alcohol, which is the hydroxyl derivative of the hydrocarbon ethane, thus—



The term phenol is used not only to describe this particular body, but also in an extended sense to include all the hydroxyl derivatives of the benzene series, which contain hydroxyl groups replacing hydrogen in the aromatic nucleus, just as the term alcohol comprises the hydroxyl derivatives of the paraffin series, although in popular language the term alcohol is used to indicate the alcohol with which we are most familiar—viz., ethyl alcohol. Although phenol is not a true acid, it is commonly spoken of as an acid, because of its behaviour with strong bases, such as sodium hydroxide, with which it reacts to form the sodium compound known as sodium carbolate or phenate, thus—



A similar reaction does not occur with ethyl alcohol or its homologues of the paraffin series, that being due to the different influence exerted upon the hydroxyl groups by the hydrocarbon residues, phenyl and ethyl. Phenyl is electro-negative, and it influences the associated hydroxyl group in such a manner as to make the hydrogen atom more easily replaceable by electro-positive elements like sodium. The acidifying influence of the  $C_6H_5$  group is, however, not powerful enough to enable phenol to decompose sodium carbonate like the true acids. In the organic acids, note that their behaviour as such is due to the carboxyl group  $-CO\cdot OH$ , in which the hydroxyl is associated with the strongly electro-negative group carbonyl  $CO$ . The term carboxyl, applied to the  $-CO\cdot OH$  group, is obtained by combining the names of its two constituents, carbonyl and hydroxyl. Cresol, the body referred to in the last official test, is a homologue of phenol, one atom of hydrogen in the benzene nucleus being replaced by methyl  $CH_3$ . Cresol being a di-substitution product of benzene,  $C_6H_4\cdot CH_3\cdot OH$  exists in three isomeric forms, known as ortho-, meta-, and para-cresol: a fluid consisting chiefly of these three isomers is used as a disinfectant under the name of trikresol. Compare in your text-book the chapter on di-substitution products of benzene. Note that the three names alcohol, phenol, and cresol end in "ol": that termination is used in chemical nomenclature to indicate that substances contain the hydroxyl group (OH). [Dose.—1 to 3 grains.]

### Acidum Carbolicum Liquefactum.

**Liquefied Phenol**, commonly known as liquefied carbolic acid, is obtained by adding 10 parts of distilled water to 100 parts of phenol.

**Characters.**—Liquefied phenol is a colourless liquid when first prepared, but it acquires a pinkish hue described under Acidum Carbolicum. It forms a clear solution at  $15.5^\circ$  C. on the addition of 18 to 27 per cent. of water. Its specific gravity is 1.064 to 1.069 at  $15.5^\circ$  C. The boiling point of the liquid rises gradually to a temperature not higher than  $182^\circ$  C.

**Notes.**—When liquefied phenol is submitted to fractional distillation the water with some of the phenol comes over in the earlier fractions, so that the boiling point, which is depressed by the presence of the water, gradually rises during distillation until that of phenol,  $182^{\circ}$ , is attained.

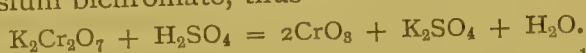
[Dose.—1 to 3 minims.]

## Acidum Chromicum.

**Chromic Anhydride**,  $\text{CrO}_3$ , is commonly termed Chromic Acid, but it only forms chromic acid when dissolved in water, thus—



The anhydride is obtained by adding excess of sulphuric acid to a strong solution of potassium bichromate, thus—



The mass of dark-red crystals which forms on cooling is washed with strong nitric acid to remove the mother liquor, and, after draining, the nitric acid is removed by evaporation in a current of warm dry air. Chromic anhydride, as met with in trade, is very deliquescent. That is said to be chiefly due to the traces of sulphuric acid adherent to the commercial substance, since the absolutely pure anhydride is not hygroscopic.

**Characters and Tests.**—Chromic acid forms crimson acicular crystals, which are very deliquescent, inodorous, and very corrosive when applied to the skin. It is freely soluble in water and ether, melts at  $192^{\circ}\text{C}$ ., and, when further heated, decomposes with evolution of oxygen, leaving a greenish black residue of chromic oxide— $2\text{CrO}_3 = \text{Cr}_2\text{O}_3 + 3\text{O}$ . This residue is insoluble in water, but if any alkaline sulphate has been left in during the process of manufacture, it will be found in the ash, and may be detected by treating the ash with water, and evaporating the filtrate to dryness. When warmed with hydrochloric acid chlorine is evolved by the oxidising action of the anhydride, which is thereby reduced to chromic chloride, thus—

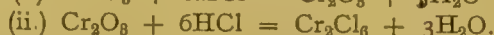


When placed in contact, at ordinary temperatures, with organic substances, such as alcohol, ether, glycerin, etc., these are oxidised, and if the proportion of organic substance to chromic acid be small, the heat produced by their oxidation is developed so rapidly, and the temperature rises so high, that active combustion, or even explosion, may follow. Solutions of chromic acid (2 in 100) acidulated with hydrochloric acid, should only yield a faint opalescence on the addition of barium chloride solution, showing absence of more than traces of sulphuric acid. Barium chromate is insoluble in water, but is not precipitated here, because free hydrochloric acid is present, in which it is easily soluble. Barium sulphate is insoluble in acids, and hence will be precipitated if any sulphate or sulphuric acid be present as impurity.

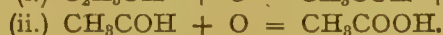
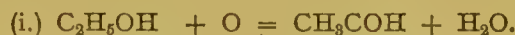
**Notes.**—The chemical behaviour of chromic acid throughout is that of an oxidising agent. It parts with half its oxygen with the greatest facility, being thereby reduced to the lower chromic oxide,  $\text{Cr}_2\text{O}_3$ . This oxide, and most of the corresponding salts, are green; hence the oxidising action is accompanied by a change in the colour of the reaction mixture from red to green. If the



oxidation be carried out in neutral or alkaline solutions, the insoluble chromic oxide appears as a green precipitate. If, however, the reaction-mixture be acid, then the corresponding salt of chromic oxide is formed, giving a green solution. Thus, with hydrochloric acid the reaction, for which the equation has been already given, may be divided into two stages, thus—



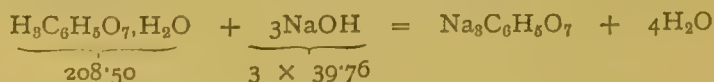
When a metal forms two or more oxides the higher oxides are anhydrides, or acid-forming oxides, and the lower ones basic. Thus,  $\text{CrO}_3$  unites with water to form chromic acid, while  $\text{Cr}_2\text{O}_3$  does not yield an acid, but combines with acids to form salts in which the chromium acts as base, *e.g.*,  $\text{Cr}_2\text{Cl}_6$ ,  $\text{Cr}_2(\text{SO}_4)_3$ , etc. The action of chromic acid upon organic substances is very energetic, the actual products varying with the temperature, concentration of solution, the solvent, and other conditions of the experiment. With cold dilute alcohol aldehyde and acetic acid are successively produced, thus—



## Acidum Citricum.

**Citric Acid** is found in many acid fruits, but is prepared commercially from lime or lemon juice. The juice contains 6 to 7 per cent. of citric acid. It is first heated and then strained to remove the coagulum of albumen and other suspended substances. From the filtrate the citric acid is separated as calcium citrate by boiling it with chalk. The calcium citrate precipitate is filtered out, washed, suspended in water, and decomposed by the addition of sulphuric acid. After removing the deposit of calcium sulphate, the filtrate is concentrated *in vacuo* and crystallised.

**Characters and Tests.**—Citric acid is found in commerce in the form of large colourless prisms belonging to the trimetric system. It is slightly soluble in ether, more soluble in alcohol, and in less than its own weight of water. A solution containing 35 grains in the fluid ounces resembles in acidity average samples of lemon juice; this standard is, however, considered too high by some authorities. In applying the official tests for citrates to citric acid, the solution must be first neutralised by sodium hydroxide, because the calcium and silver citrates, upon whose production as precipitates these tests depend, are easily soluble in weak acid. Each gramme of citric acid requires for neutralisation 14.3 C.c. of normal sodium hydroxide solution, thus—

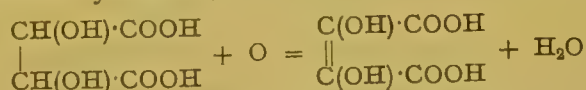


1,000 C.c. of normal sodium hydroxide solution will neutralise  $\frac{208.50}{3} = 69.5$  grammes citric acid, therefore—

1 C.c.	is equivalent to	0.0695	gramme of citric acid
and 14.3 C.c.	" "	0.0695 × 14.3	" "
		= 0.9938	" "
		or 99.38 per cent.	

Phenol-phthalein should be used as indicator, because aqueous solutions of the neutral alkali citrates are alkaline to litmus. Citric acid should be free from copper and iron, and contain not more than traces of calcium and sulphates. Its solution should also be free from metallic particles, removed mechanically from the pans in which it has been manufactured. Lead derived from leaden pans is best detected by adding to a strong solution of the acid, nearly neutralised by ammonia, three or four times its bulk of saturated  $\text{H}_2\text{S}$  water. This process is said to afford more delicate indications of the presence of traces of lead than can be obtained by bubbling the gas through the solution. On allowing the mixture to stand five minutes, no darkening of colour, such as would be caused by lead sulphide, should result. Tartaric acid is detected by the following test:—To an aqueous solution of the acid add one drop of ferrous sulphate solution, and then a few drops of solution of hydrogen peroxide, and finally an excess of solution of potassium hydroxide. A light violet to dark purple coloration will occur if tartaric acid be present. An alternative test for tartaric acid is as follows:—Place 1 gramme of the acid to be examined in a test tube, add 5 C.c. of solution of ammonium molybdate, and then two or three drops of solution of hydrogen peroxide. Then shake the contents of the test tube, and immerse the tube in boiling water for ten minutes; no blue coloration should appear. Citric acid should not yield more than 0.05 per cent. of ash when thoroughly incinerated, showing absence of more than traces of fixed salts.

**Notes.**—The first test for tartaric acid when present in citric acid depends upon the formation of a derivative, di-oxy-maleic acid, which yields the purple colour with potassium hydroxide, thus—



The oxidising agent is the hydrogen peroxide, the trace of ferrous sulphate acting as a carrier of oxygen between the peroxide and the tartaric acid. The importance of the test lies in the fact that none of the allied organic acids (citric, malic, lactic, etc.), or sugar, produce this di-oxy-maleic acid when oxidised. The blue colour produced by tartaric acid with ammonium molybdate is due to the reduction of the molybdate to a lower oxide of molybdenum. The test applies also to other reducing agents, such as metallic particles, derived from utensils employed in manufacture, because those act as reducing agents by virtue of the hydrogen they are capable of yielding in acid solutions.

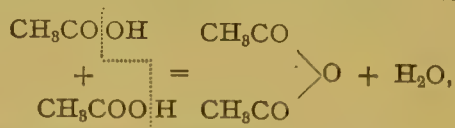
[Dose.—5 to 20 grains.]

## Acidum Gallicum.

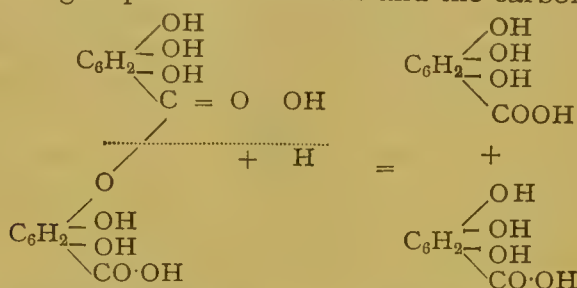
**Gallic Acid** is tri-hydroxy-benzoic acid and crystallises with one molecule of water,  $\text{C}_6\text{H}_2(\text{OH})_3\text{COOH}$ ,  $\text{H}_2\text{O}$ . It occurs in small quantities in galls, but is obtained more readily by the hydrolysis of tannic acid, on boiling that substance with dilute sulphuric acid. Each molecule of tannic acid takes up one molecule of water, and yields two molecules of gallic acid. This behaviour



indicates that tannic acid stands to gallic acid in the relation of an anhydride to an acid, but inasmuch as tannic acid itself is an acid, and contains a carboxyl group, the anhydride formation is not due to the elimination of water from the carboxyl groups of two molecules of acid, as in the formation of acetic anhydride—



but from an alcoholic group of one molecule and the carboxyl group of another.

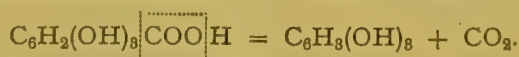


1 molecule tannic acid.      2 molecules gallic acid.

**Characters and Tests.**—Gallic acid occurs in acicular prisms or silky needles, sometimes nearly white, but generally of a slight brownish tint; odourless, and having a faint acid taste. It is soluble in 100 parts of cold water, or 3 parts of boiling water, in 5 parts of alcohol (90 per cent.), 40 parts of ether, or 12 parts of glycerin. It yields a bluish-black precipitate with ferric chloride solution. When dried at 100° C. it loses the water of crystallisation, which should correspond to a loss of 9.5 per cent. For 1 molecular weight of gallic acid (186.65) loses 1 molecule of water (17.88), and

$$186.65 : 17.88 :: 100 : 9.58.$$

Gallic acid should be free from sulphuric acid. Its aqueous solution gives no precipitates with solutions of isinglass, albumin, and alkaloids, all of which form insoluble compounds with tannic acid. The official statement that gallic acid solution gives no precipitate with tartar emetic should be corrected. When gallic acid is heated above its melting point carbon dioxide is evolved and pyrogallol sublimes—



The acid should leave no residue on incineration.

**Notes.**—The comparative solubility of gallic acid in hot and cold water should be carefully remembered. At ordinary temperatures its solubility in water is only between 4 and 5 grains to the fluid ounce. If more than that proportion be ordered in a prescription, it must be finely powdered and sent out suspended. The acid should not be dissolved by the aid of heat, since the excess will crystallise out on cooling. The statement that gallic acid gives no precipitate with tartar emetic is incorrect.

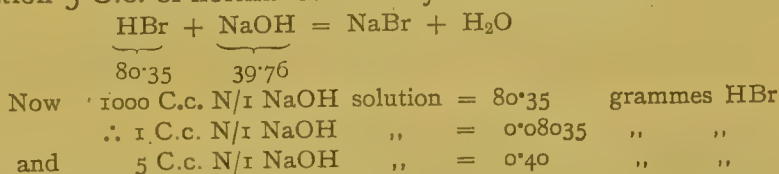
[Dose.—5 to 15 grains.]

## Acidum Hydrobromicum Dilutum.

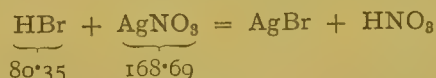
**Diluted Hydrobromic Acid** consists of an aqueous solution containing 10 per cent. by weight of hydrogen bromide, HBr, hydrobromic

acid gas. It may be prepared by distilling potassium bromide with concentrated phosphoric acid; the hydrobromic acid so liberated is condensed in water while a residue of potassium phosphate is left in the retort.

**Characters and Tests.**—Diluted hydrobromic acid is a clear, colourless, inodorous liquid, yielding, when neutralised, the reactions characteristic of bromides. Its specific gravity is 1·077. Four grammes of the acid require for neutralisation 5 C.c. of normal sodium hydroxide solution.

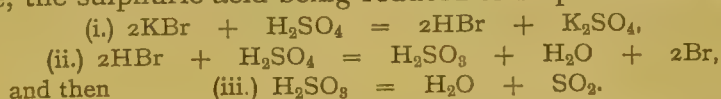


0·40 gramme of HBr in 4 grammes of the official acid is equivalent to 10 per cent. Since the official volumetric solution of silver nitrate is decinormal the same weight of Acidum Hydrobromicum Dilutum (4 grammes) will require for complete precipitation  $5 \times 10$  C.c. of N/10 AgNO<sub>3</sub> solution, according to the equation—



The official acid should be free from arsenic, barium, chlorides, phosphates, sulphates or sulphites. Barium may be found in acid manufactured by adding sulphuric acid to a solution of barium bromide, owing to the incomplete precipitation of the barium. It should leave no residue on evaporation to dryness, showing absence of fixed impurities.

**Notes.**—Although hydrobromic acid is liberated from bromides by the action of sulphuric acid this does not provide a practical means of preparing a pure solution of the acid, because when heat is applied to distil the hydrobromic acid this body is partly oxidised by the sulphuric acid with liberation of bromine, the sulphuric acid being reduced to sulphurous acid.



The reaction (ii.) does not take place when the sulphuric acid is well diluted. The difficulty cannot, however, be avoided by distilling a diluted solution of KBr and H<sub>2</sub>SO<sub>4</sub>, because the HBr is so soluble in water that it would only be expelled by concentrating the liquor until the limit was approached for oxidation of the HBr to commence. By using strong phosphoric acid, the hydrobromic acid can be obtained by distillation, since there is no secondary reaction between these two acids.

[Dose.—15 to 60 minims.]

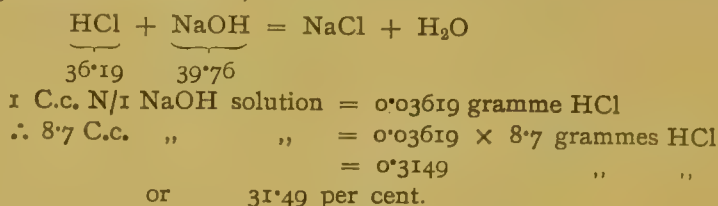
## Acidum Hydrochloricum.

**Hydrochloric Acid** is a liquid containing 31·79 per cent. by weight of hydrogen chloride, HCl, hydrochloric acid gas. It is obtained by distilling sodium chloride with sulphuric acid, and dissolving the resulting hydrochloric acid in water. There is no secondary reaction between hydrochloric and sulphuric acids; compare Acidum Hydrobromicum Dilutum.

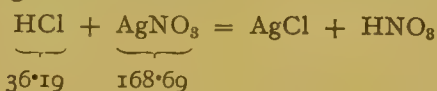


## ACIDUM HYDROCHLORICUM.

**Characters and Tests.**—Hydrochloric acid is a colourless and strongly acid liquid, emitting white pungent fumes. It yields, when neutralised, the reactions characteristic of chlorides. Its specific gravity is 1.160. One gramme, diluted with water, should neutralise not less than 8.7 C.c. of normal sodium hydroxide solution, thus—



For complete precipitation with silver nitrate, 1 gramme of Acidum Hydrochloricum will require 87 C.c. of the volumetric solution of silver nitrate, since this is decinormal, and each cubic centimetre will be, therefore, equivalent to 0.003619 gramme HCl.



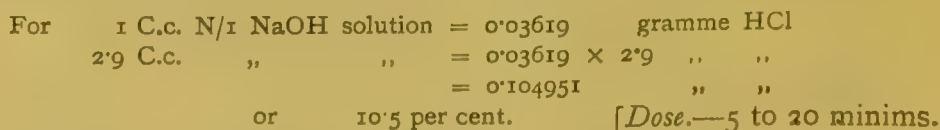
A residue is usually left on evaporation of the acid, but should not exceed 0.1 per cent.; the diluted acid should give no decided reaction with the tests, for arsenium, lead, copper, iron, aluminium, bromides, iodides, sulphates, and sulphites. Absence of free chlorine is shown by adding to the well-diluted acid a few drops of solution of potassium iodide, and then mucilage of starch; no blue colour should appear. If chlorine be present, this displaces an equivalent quantity of iodine from the iodide, and the free iodine then forms the characteristic blue iodide of starch.

**Notes.**—Before applying reagents for the detection of metallic and other impurities, hydrochloric acid must be diluted with water, because many reagents are insoluble in strong hydrochloric acid (notably  $\text{BaCl}_2$ ), and hence are themselves precipitated when their aqueous solutions are added to the undiluted acid.

## Acidum Hydrochloricum Dilutum.

**Diluted Hydrochloric Acid** is obtained by diluting the official Acidum Hydrochloricum with water, so that the diluted product shall contain 10.58 per cent. by weight of real HCl.

**Tests.**—Specific gravity 1.052. It should respond to the same tests, and be free from the same impurities as described under Acidum Hydrochloricum. One gramme neutralises 2.9 C.c. of normal sodium hydroxide solution.



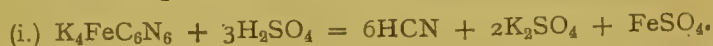
## Acidum Hydrocyanicum Dilutum.

**Diluted Hydrocyanic Acid** is an aqueous solution containing 2 per cent. of real hydrocyanic acid, HCN. It is obtained by distilling potassium ferrocyanide

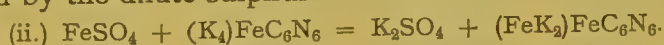
with dilute sulphuric acid and condensing the distillate. The equation given for this reaction is:



According to this reaction only half of the cyanogen is obtained in the form of hydrogen cyanide, the other half being left in the retort as a yellowish-green insoluble double ferrocyanide of iron and potassium. This may be explained as follows:—The ferrocyanide is decomposed by the sulphuric acid yielding hydrocyanic acid and sulphates of iron and potassium, thus—

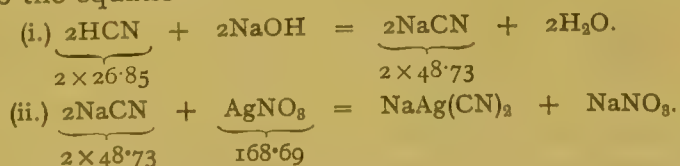


The ferrous sulphate immediately reacts with some of the undecomposed potassium ferrocyanide forming the insoluble double ferrocyanide, which is not further affected by the dilute sulphuric acid—



Diluted hydrocyanic acid should be stored in a dark place, in small stoppered bottles of amber glass, the stoppers being tied over with impervious tissue, and the bottles inverted. The official solution of this acid may lose its strength through careless storage: (1) by volatilisation; (2) by decomposition. The latter cause is particularly interesting. The hydrocyanic acid reacts with water, thus:— $\text{HCN} + 2\text{H}_2\text{O} = \text{H}\cdot\text{COONH}_4$ , the ammonium salt of formic acid being produced. This is known in organic chemistry as the cyanide synthesis, because it enables one to make from any given hydrocarbon the acid containing one atom of carbon more. Thus from ethane we can pass to propionic acid by preparing (1) ethyl chloride, (2) ethyl cyanide, and hydrolysing the latter.  $\text{C}_2\text{H}_6 \rightarrow \text{C}_2\text{H}_5\text{Cl} \rightarrow \text{C}_2\text{H}_5\text{CN}$ . The essential feature of the change consists in the conversion of a cyanogen group into a carboxyl group— $\text{R}\cdot\text{CN}$  into  $\text{R}\cdot\text{CO}\cdot\text{OH}$ . The conversion of hydrocyanic acid into ammonium formate takes place slowly; it is hastened by exposure to light, and the hydrolysis of this and other organic cyanides can be quickly accomplished by boiling with sodium or potassium hydroxide.

**Characters and Tests.**—Diluted hydrocyanic acid is a colourless liquid with a characteristic odour. Its specific gravity should be 0.997. It only slightly reddens litmus, and it yields, when neutralised, the reactions characteristic of cyanides. The determination of strength is made by silver nitrate solution, and is based upon the formation of a soluble double cyanide of silver and sodium, which is decomposed with formation of insoluble silver cyanide, when more silver nitrate is added beyond the quantity required for its formation according to the equations:—



With more silver nitrate the soluble double cyanide is decomposed, thus—



For this reaction the hydrocyanic acid must be converted into sodium cyanide; but it is not possible to specify the exact amount of sodium



hydroxide necessary for the purpose. A large excess of alkali is detrimental, since it uses up the silver solution, and makes the reading of the burette too high. It is best, therefore, to dilute the acid to be titrated, add litmus solution, and then a dilute solution of soda, until a distinct blue colour is obtained. The silver solution is then run in until the permanent precipitate of  $\text{AgCN}$  is obtained, more soda being added from time to time if the litmus turns red. The final precipitate must be obtained in an alkaline solution, showing that all the hydrocyanic acid has been converted into sodium cyanide. Titrated in this manner, 1 gramme of Acidum Hydrocyanicum Dilutum should require 3.7 C.c. of decinormal silver nitrate solution. For  $\text{AgNO}_3/10$ , by the above equations, is equivalent to  $2\text{NaCN}/10$ , and therefore to  $2\text{HCN}/10$ .

$$\text{Therefore 1 C.c. N/10 AgNO}_3 \text{ sol.} = \frac{2 \times 26.85}{10 \times 1000} \text{ grammes HCN}$$

$$= 0.00537 \quad "$$

$$\text{Therefore 3.7 C.c.} \quad " \quad " = 0.00537 \times 3.7 \quad "$$

$$= 0.019869 \quad "$$

equivalent to 1.9869 per cent.

If 5 C.c. be evaporated in a platinum dish it should leave no residue, and the acid should yield only the slightest reactions with the tests for sulphates or chlorides, showing that only traces of mineral acids are present. The addition of a small quantity of hydrochloric or sulphuric acid is said to retard the decomposition of the solution.

**Notes.**—The strength of the solution cannot be determined by direct titration with sodium hydroxide, because hydrocyanic acid is a very weak acid, while sodium cyanide, although neutral in composition, reacts strongly alkaline to indicators in aqueous solution. There is, therefore, no means of indicating sharply the termination of the reaction:  $\text{HCN} + \text{NaOH} = \text{NaCN} + \text{H}_2\text{O}$ .

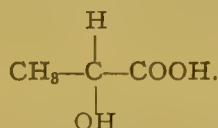
[Dose.—2 to 6 minims.

## Acidum Lacticum.

**Lactic Acid** is officially described as a liquid containing 75 per cent. of hydrogen lactate,  $\text{CH}_3\cdot\text{CH}(\text{OH})\cdot\text{COOH}$ , and 25 per cent. of water. Pure anhydrous lactic acid is unknown, for concentration of its solution much beyond the strength of the official acidum lacticum leads to its decomposition. Lactic acid is so called from its discovery by Scheele (1780) in sour milk. It is formed in sour milk by the fermentation of the milk sugar under the influence of the lactic acid ferment, known as *Bacillus acidi lactici*. Sugars are susceptible to the action of a number of ferment organisms, such as yeast and the bacilli which produce lactic and butyric acids. Each organism produces fermentation products peculiar to itself and manifests its action most favourably under certain conditions. Three factors are of the highest importance in determining the relative activity of these ferments in acting upon sugar solutions, (1) temperature; (2) reaction of the fluid; (3) presence of nutrient substances in addition to sugar. Since these ferment organisms are widely distributed it is hardly possible, on the large scale, to carry out a pure fermentation—*i.e.*, one in which only a single organism is concerned. The conditions, however, can be arranged so that they are most favourable for the development

of any desired organism and so obtain chiefly the products characteristic of the fermentative activity of this organism. For the development of the *Bacillus acidilactici* the most favourable conditions are (1) temperature about 35° C.; (2) neutral or faintly alkaline solution; (3) presence of proteids (albuminous substances). To obtain lactic acid from sugar, decayed cheese is added; this consists chiefly of casein (proteids) and contains abundance of the lactic acid bacilli. Chalk or zinc oxide is also added to neutralise the acid as fast as it is produced (since the activity of the lactic ferment is diminished by the presence of free acid), and the mixture is set aside and frequently stirred for about a week, at a temperature of 35°-40° C. It is then boiled, filtered, and the filtrate evaporated to crystallise out the zinc or calcium lactate. From the solution of the calcium salt the acid is obtained by the addition of the required quantity of sulphuric acid, and from the zinc salt by precipitating the zinc as sulphide, with hydrogen sulphide. After removing the calcium sulphate or zinc sulphide by filtration, the filtrate is evaporated on the water bath. If the fermentation mixture be allowed to become acid, or to stand too long, then butyric fermentation sets in, by which the lactic is converted into butyric acid, hydrogen being evolved. Milk sugar is officially specified as the source of lactic acid, but glucose or invert sugar is also used for the purpose. The empirical formula for lactic acid,  $C_3H_6O_3$ , is exactly half that of glucose,  $C_6H_{12}O_6$ ; but it is not known how the bacillus effects the conversion of the sugar to lactic acid. Lactic acid,  $\underset{\beta}{CH_3} \cdot \underset{\alpha}{CH(OH)} \cdot COOH$ ,

is also known as  $\alpha$ -hydroxy-propionic acid, since it is derived from propionic acid by substitution of hydroxyl for hydrogen combined with the carbon atom nearest the carboxyl group. This nomenclature is adopted in order to distinguish isomeric substances, the successive atoms in the carbon chain being distinguished by the Greek letters  $\alpha$ ,  $\beta$ ,  $\gamma$ , proceeding from the end next to the characteristic group of the mother substance. Thus  $CH_2(OH) \cdot CH_2 \cdot COOH$  is  $\beta$ -hydroxy-propionic acid, otherwise known as hydracrylic acid. Inspection of the formula for lactic acid shows that it contains one asymmetric carbon atom—i.e., a carbon atom combined with four different groups or elements: in this case  $CH_3$ , H, OH, and COOH, thus—



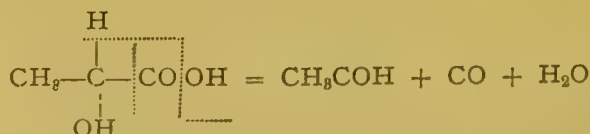
It can, therefore, exist in three stereo-isomeric forms: (1) dextro-rotatory, (2) lævo-rotatory, and (3) racemic or inactive. The last is produced by mixing equal proportions of the dextro- and lævo-varieties, and is the kind obtained in the fermentation of lactose by means of putrid cheese. Dextro-lactic acid occurs in flesh, and is known as para- or sarco-lactic acid, while lævo-lactic acid has been obtained by the fermentative activity of a special organism on sugar solutions. All three can also be produced by synthetical processes.

**Characters and Tests.**—Lactic acid is a colourless, syrupy, hygroscopic liquid, without odour, but with a sour taste, and acid reaction. It is miscible

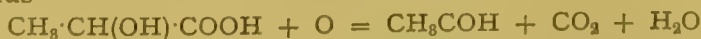


in all proportions with water, alcohol (90 per cent.), and ether, but is nearly insoluble in chloroform. Its specific gravity is 1.21. When heated to about 150° C., it vaporises, and at a slightly higher temperature it decomposes, giving off inflammable gases; on ignition, those burn with a flame which is blue at first, but becomes more luminous as the temperature rises, owing to the presence, in the decomposition products, of substances rich in carbon. Aldehyde, recognised by its odour, is also produced when lactic acid is oxidised by warming it with potassium permanganate. It leaves a residue not exceeding 0.5 per cent. on incineration showing absence of more than unavoidable small quantities of mineral impurities. It should be free from lead, copper, arsenium, iron, and aluminium, also from chlorides, citrates, oxalates, phosphates, sulphates and tartrates. When diluted with water, it gives no precipitate with copper sulphate solution, showing absence of sarcolactic acid, which forms a sparingly soluble copper salt. Absence of milk or grape sugar is shown by the non-reduction of Fehling's solution (potassio-cupric tartrate) when this reagent is added, and the mixture boiled. Adulteration with glycerin is revealed by adding excess of zinc carbonate to convert the lactic acid into zinc lactate; the whole is then evaporated cautiously on a water-bath. Any glycerin in the residue may then be extracted with absolute alcohol, in which glycerin is soluble; the alcoholic extract, when cautiously evaporated, will leave a sticky, sweet residue of glycerin. The presence of butyric, and other fatty acids, is revealed by their characteristic rancid odour when the acid is gently warmed. Organic impurities, generally, are detected by the charring produced when the lactic acid is poured carefully upon strong sulphuric acid, which has no charring action upon pure lactic acid. Since lactic acid is freely miscible with ether, many possible impurities insoluble in ether, such as gum, sugar, mannite and calcium phosphate may be detected by adding the acid, drop by drop, to twice its volume of ether; no turbidity should be produced as the drops of acid fall through the ether. Malic or sulphuric acid may be detected by the formation of insoluble lead malate or sulphate when solution of lead subacetate is added, lead lactate being soluble.

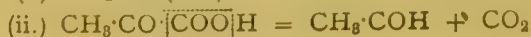
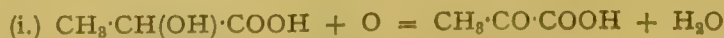
**Notes.**—When lactic acid is heated cautiously, the main products are aldehyde, water, and carbon monoxide, the last-mentioned being, of course, inflammable.



The oxidation of lactic acid by potassium permanganate results in the formation of CO<sub>2</sub>, thus—

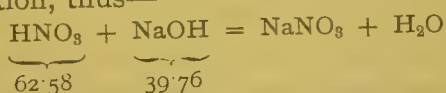


This reaction occurs in two stages, 2H being first removed, with formation of pyrroacemic acid—a ketone acid—which is then decomposed into aldehyde and CO<sub>2</sub>.



**Nitric Acid** is officially described as a liquid containing nearly 70 per cent. by weight of real nitric acid,  $\text{HNO}_3$ , and 30 per cent. of water, obtained by distilling sodium or potassium nitrate with sulphuric acid. A stronger acid than this is met with, known as fuming nitric acid, which contains 85-90 per cent. of  $\text{HNO}_3$ . This is unstable, and partly decomposes, yielding some nitric peroxide and nitrous acid, which communicate to it a yellowish red colour.

**Characters and Tests.**—Nitric acid is a clear colourless liquid, emitting corrosive fumes. It yields, when neutralised, the reactions characteristic of nitrates. When submitted to distillation, under normal atmospheric pressure, an acid of the official strength boils constantly at  $121^{\circ}$  C., the proportions of  $\text{HNO}_3$  and water passing over remaining unchanged throughout the distillation. If an acid weaker than 70 per cent. be distilled, a larger proportion of water than nitric acid first passes over, until the residue in the still contains 70 per cent. of  $\text{HNO}_3$ . With an acid stronger than 70 per cent. the reverse happens, a larger proportion of  $\text{HNO}_3$  first coming over until the residue is reduced to 70 per cent. strength. The official Acidum Nitricum has a specific gravity of 1.42. Each gramme diluted with water requires for neutralisation 11.1 C.c. of N/1 NaOH solution, thus—



Therefore 1 C.c. N/1 NaOH solution = 0.06258 gramme  $\text{HNO}_3$   
 and 11.1 " " = 0.695 " "  
 equivalent to 69.5 per cent.

Nitric acid should be free from any appreciable quantity of lead, copper, arsenium, iron, chlorides, bromates, iodates, and sulphates, and the residue left on evaporation should not exceed 0.05 per cent.

**Notes.**—Nitric acid manufactured from crude sodium nitrate (Chili saltpetre) sometimes contains bromic and iodic acids derived from bromides and iodides occurring in the native salt. HBr and HI are formed from those compounds by the action of the sulphuric acid, the nitric acid afterwards oxidising them to  $\text{HBrO}_3$  and  $\text{HIO}_3$ . Before applying the tests for bromates and iodates the nitric acid must be diluted and exactly neutralised with ammonia or soda.

**Diluted Nitric Acid** is obtained by diluting stronger nitric acid with water so that the diluted product shall contain 17.44 per cent. of  $\text{HNO}_3$ .

**Tests.**—Diluted nitric acid should be of specific gravity 1.101. Each gramme neutralises 2.7 C.c. of normal sodium hydroxide solution.

[Dose.—5 to 20 minims.

**Diluted Nitro-Hydrochloric Acid** is an aqueous solution containing free chlorine, hydrochloric, nitric, and nitrous acids, and other bodies, prepared



by mixing 3 fluid ounces of nitric acid, 4 of hydrochloric acid, and 25 of water, the mixture being allowed to stand fourteen days before being used. A mixture of strong nitric and hydrochloric acids constitutes aqua regia, so-called from its power of dissolving gold, the "King of Metals." When HCl and HNO<sub>3</sub> are mixed mutual oxidation and reduction occur, with formation of nitrous acid and free chlorine—



**Characters and Tests.**—Diluted nitro-hydrochloric acid is a colourless liquid with a pungent taste and odour. Its specific gravity should be 1.047. Four grammes neutralise about 10 C.c. of normal sodium hydroxide solution.

**Notes.**—In the official Acidum Nitro-Hydrochloricum Dilutum the acids are mixed in a diluted condition—the formation of nitrous acid and chlorine only takes place slowly under those conditions, and to a limited extent. Other reactions occur at the same time, leading to the formation of nitric oxide, which combines with chlorine to form nitrosyl chloride, NOCl.

[Dose.—5 to 20 minims.

## Acidum Oleicum.

**Oleic Acid**, in the form of glyceryl ester, is a widely distributed constituent of animal and vegetable fats. It constitutes the major portion of olive and almond oils and a very considerable proportion of lard and tallow. In all the common oils and fats it is associated chiefly with the glyceryl esters of stearic and palmitic acids, these three glyceryl esters being known as olein, stearin and palmitin respectively. To obtain the free fatty acids from oils, two processes are followed: (1) The oil is saponified by caustic alkali, the alkali salts (soaps) dissolved in water, and the fatty acids liberated by addition of hydrochloric or sulphuric acid. Taking olein as a type these reactions may be represented thus—



When the mineral acid is added to the solution of the soap and the mixture heated, the liberated fatty acids, being insoluble in and lighter than water, rise to the surface and form a distinct layer above the aqueous solution of salt. (2) The second general process is to saponify the oil or fat with superheated steam, *i.e.*, steam under pressure and therefore at a higher temperature than 100° C. the temperature at which water boils in open vessels under ordinary atmospheric pressure. At the higher temperature the glyceryl compound is converted into free acid and glycerin according to the following equation—



When the decomposition is complete the product separates into two layers, an upper one of fatty acid and a lower one consisting of an aqueous solution of glycerin. It should be noted that this reaction between oil and water does not

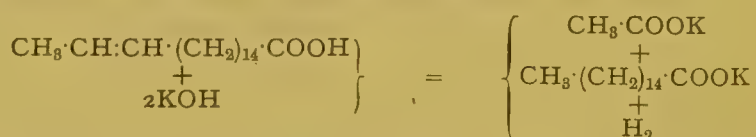
occur when the two substances are boiled together in an open pan, *i.e.*, at  $100^{\circ}\text{C}$ . In both processes the layer of fatty acids obtained from various oils and fats consists of a mixture of the fatty acids characteristic of the fat or oil employed. Thus, in the case of almond oil it is almost pure oleic acid, while that from tallow contains about 50 per cent. of oleic acid, the rest being stearic and palmitic acids. The separation of oleic acid in an absolutely pure condition from those mixtures is exceedingly difficult and tedious, but for commercial and medicinal purposes the presence of small proportions of stearic and other fatty acids is not of much importance. The purification of oleic acid is to some extent accomplished by a repeated process of cooling and solidification, based upon the fact that oleic acid remains fluid down to about  $5^{\circ}\text{C}$ ., while stearic acid becomes solid at  $69.2^{\circ}\text{C}$ . and palmitic acid at  $62^{\circ}\text{C}$ . The cooled and partly solidified mixture of fatty acids is subjected to hydraulic pressure and the expressed portion, consisting chiefly of oleic acid, is obtained sufficiently pure by repeated treatment.

**Characters and Tests.**—Oleic acid when pure is colourless and neutral to litmus, but, as met with in commerce, it is a straw-coloured liquid, having usually a faint rancid odour and a slight acid reaction, due to the presence of traces of lower water-soluble fatty acids produced during manufacture or derived from the fat or oil used as a source of the oleic acid. Those fatty acids, to which the rancid odour and acid reaction are due may also arise from oxidation of the oleic acid from exposure to air, and will therefore be found more abundantly in old samples or in those carelessly stored. Oleic acid is insoluble in water, but freely soluble in 90 per cent. alcohol (*vide* Oleum Olivæ), chloroform, or ether. When cooled it solidifies at  $4.5$  to  $5^{\circ}\text{C}$ ., and then only re-melts when the temperature rises to between  $13.3$  and  $15.5^{\circ}\text{C}$ . Its specific gravity is  $0.890$  to  $0.910$ . To detect stearic or palmitic acids the oleic acid, in alcoholic solution, is first converted into the sodium salt by a slight excess of sodium hydroxide, the termination of the reaction being indicated by the production of a red colour with phenol-phthalein. A very strong aqueous solution of alkali is used in order to add as little water as possible during the process, because the neutralisation of oleic acid does not occur either rapidly or completely in aqueous solutions. That is partly accounted for by the insolubility of oleic acid in water, but it is also noteworthy that water partly hydrolyses soaps into fatty acid and alkali, so that such solutions are always alkaline. The slight excess of soda necessary to give the red colour with phenol-phthalein is then neutralised by acetic acid, because a turbidity—due to lead hydroxide—would be produced by the sodium hydroxide on the subsequent addition of lead acetate solution. The neutralised fluid is filtered and the filtrate, consisting of an alcoholic solution of the sodium salts of the fatty acids, is then mixed with an equal volume of ether, and lead acetate solution added. The addition of lead acetate gives no precipitate in the case of pure oleic acid, because lead oleate is soluble in the mixture of alcohol and ether, while lead stearate or palmitate is insoluble. The official acid should give only a slight turbidity, showing absence of more than traces of stearic or palmitic acids. Much acid of sufficient purity for medicinal use is excluded by the official tests.

**Notes.**—The unsaturated series of acids to which oleic acid belongs is known as the acrylic series, from the name of the first and simplest member, acrylic



acid. The formulæ for stearic acid,  $C_{17}H_{35}\cdot COOH$ , and oleic acid,  $C_{17}H_{33}\cdot COOH$ , show that they are homologous with acetic acid,  $CH_3\cdot COOH$ , and acrylic acid,  $C_3H_3\cdot COOH$  respectively. The unsaturated acids take up two atoms of hydrogen when acted upon by reducing agents, such as hydriodic acid, and yield saturated acids containing the same number of carbon atoms. Acrylic acid,  $C_3H_3\cdot COOH$ , yields propionic acid,  $C_3H_5\cdot COOH$ , for example, and oleic acid,  $C_{17}H_{33}\cdot COOH$ , becomes stearic acid,  $C_{17}H_{35}\cdot COOH$ . Those unsaturated acids also take up two atoms of bromine (or chlorine), yielding di-bromo derivatives of the corresponding saturated acids, like the unsaturated hydrocarbons, *e.g.*, ethylene,  $C_2H_4$  (the simplest hydrocarbon of the series) takes up bromine to form ethylene dibromide,  $C_2H_4Br_2$ , or di-brom-ethane. This faculty is utilised in analysis to distinguish the acids of the unsaturated series (*e.g.*, oleic acid) from those of the saturated series (*e.g.*, stearic acid) or to determine the proportion of each in a mixture. Not only do the fatty acids behave in this manner, but also their glyceryl esters, which constitute the main portion of fixed oils and fats; and the amount of bromine taken up, known technically as "bromine absorption," becomes an important factor in the identification or determination of the purity of bodies of this class. In the unsaturated acids of the acrylic series, the existence of a double bond between two of the carbon atoms is assumed. In a compound like oleic acid the determination of the exact position of this double bond in the carbon chain is difficult. The method adopted — and this has a general significance for all similarly constituted bodies — is to study the decomposition products obtained by oxidation. It has been found in the case of the simpler compounds that the chain is broken between the doubly-linked carbon atoms. In the case of oleic acid, however, the results obtained by the action of various oxidising agents are not concordant. When fused with potassium hydroxide, acetate and palmitate of potassium result, and that would seem to show that the double bond is between the second and third carbon atoms, thus—

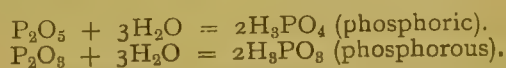


On the other hand, certain oxidising agents, at comparatively low temperatures, yield, among other products, acids having nine carbon atoms in the molecule, and that would appear to indicate that the double bond occurs in the middle of the carbon chain, as shown by the formula in the official monograph— $CH_3(CH_2)_7CH:CH(CH_2)_7COOH$ . The matter cannot be considered definitely settled at present, but the latter of the two formulæ which have been discussed is maintained by some to represent the constitution of oleic acid, because its oxidation, by fusion with potassium hydroxide, necessitates the application of a high temperature. At high temperatures atomic rearrangements in the molecule often occur, so that the constitution of a body cannot always be deduced correctly from the decomposition products obtained. Elaïdic acid, obtained by the action of nitrous acid on oleic acid and isomeric with it, probably owes its isomerism to an alteration in the position of the

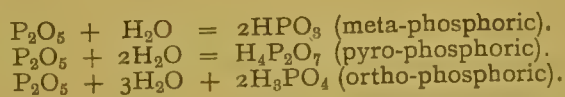
double bond. The same remark applies to the isomerism of the glyceride elaidin with olein. Further particulars relating to the constitution of oils will be found in the portion of the monograph on "Olea," dealing with fixed oils and fats.

## Acidum Phosphoricum Concentratum.

**Concentrated Phosphoric Acid** is an aqueous solution of ortho-phosphoric acid, containing 66·3 per cent.  $\text{H}_3\text{PO}_4$ . It is made from phosphorus, chiefly by two methods, both of which involve oxidation of the phosphorus. In the direct oxidation process referred to in the Pharmacopœia the oxygen is derived from the air. (1) When phosphorus is burned in air the main product is the pentoxide,  $\text{P}_2\text{O}_5$ , known also as phosphoric anhydride, because it combines with water to form phosphoric acid. At the same time there is always formed some of the lower oxide,  $\text{P}_2\text{O}_3$ , known as trioxide or phosphorous anhydride, because it forms with water phosphorous acid, thus—



The formation of ortho-phosphoric acid,  $\text{H}_3\text{PO}_4$ , does not occur completely when the anhydride is merely added to water, for that body takes up successively one, two, and three molecules of water, forming the three acids distinguished by the prefixes meta-, pyro-, and ortho-, the last being the official acid, thus—

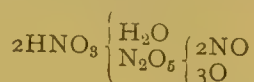


The complete hydration of the anhydride to the ortho acid is hastened by boiling, and a little nitric acid also aids the process of hydration, besides providing for the oxidation of any phosphorous to phosphoric acid. Nitric acid is one of the most commonly used oxidising agents. The products of its reduction are volatile, and any excess is easily removed by evaporation. Many other oxidising agents would convert the phosphorous to phosphoric acid, *e.g.*, potassium permanganate. But the reduction products from that compound, *viz.*, the potassium and manganese salts, are not volatile, and could not be easily removed from the phosphoric acid. (2) In the other process for the preparation of phosphoric acid the phosphorus is oxidised by boiling it with fairly strong nitric acid in a vessel connected with a reflux condenser, so that the nitric acid and water which are driven off are continually returned to the flask. The first product of oxidation, phosphoric anhydride, does not actually appear in this process, because it unites at once with the water present to form phosphoric acid. The nitric acid is reduced to nitric oxide, and when all the phosphorus has disappeared the excess of nitric acid left in the fluid is removed by concentration in an open dish. The equation given for this reaction—

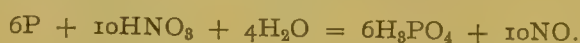




may be easily interpreted by observing that when the nitric acid, employed as an oxidising agent, is reduced to nitric oxide every two molecules of nitric acid yield three atoms of available oxygen, thus—



Since two atoms of phosphorus require five of oxygen for conversion to phosphoric anhydride, the simplest relationship of phosphorus to nitric acid which satisfies those conditions is  $6\text{P}$  (requiring  $15\text{O}$  to produce  $3\text{P}_2\text{O}_5$ ) to  $10\text{HNO}_3$  (which yield  $15\text{O}$  available for oxidation);  $3\text{P}_2\text{O}_5$  require  $9\text{H}_2\text{O}$  for conversion to  $6\text{H}_3\text{PO}_4$ , but since  $5\text{H}_2\text{O}$  are included in the decomposition products of the nitric acid the equation becomes



**Characters and Tests.**—Concentrated phosphoric acid is a colourless syrupy liquid with an acid reaction and taste. Evaporated, it leaves a residue which melts at a low red heat and, when cold, forms a glass-like mass which consists of metaphosphoric acid formed by loss of water, thus—



When neutralised by soda or ammonia the neutralised product yields the reactions characteristic of phosphates; the fluid should be diluted before applying the tests. The specific gravity of the acid of the official strength is  $1.5$ . An acid having a specific gravity  $1.75$  is met with in commerce and is nearly absolute  $\text{H}_3\text{PO}_4$ . The strength of the acid is determined in the following manner:—Place  $2.5$  grammes of finely powdered lead oxide (free from carbonate) in a crucible and add  $1$  gramme of the acid to be examined: evaporate the mixture to dryness at a gentle heat, to avoid loss by spurting, finally heating the contents of the crucible to dull redness; cool and weigh. The residue should weigh  $2.98$  grammes, showing an increase in weight of  $0.48$  gramme. The test is based upon the formation of lead phosphate:

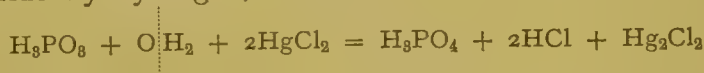


An excess of lead oxide is employed in order to ensure the retention of all the phosphoric anhydride, and since the lead phosphate may be regarded as a compound of  $\text{PbO}$  and  $\text{P}_2\text{O}_5$  ( $\text{Pb}_3(\text{PO}_4)_2 = 3\text{PbO} + \text{P}_2\text{O}_5$ ) the observed increase in weight ( $0.48$  gramme) is due to phosphoric anhydride fixed by the lead oxide. Now one molecular weight  $\text{P}_2\text{O}_5$  ( $141$ ) is derived from two molecular weights,  $2\text{H}_3\text{PO}_4$  ( $97.32 \times 2 = 194.64$ ); therefore  $0.48$  gramme  $\text{P}_2\text{O}_5$  indicates  $0.663$  gramme  $\text{H}_3\text{PO}_4$  in the one gramme taken for analysis, because

$$141 : 194.64 :: 0.48 : 0.663,$$

and  $0.663$  gramme  $\text{H}_3\text{PO}_4$  in  $1$  gramme of Acidum Phosphoricum Concentratum is equivalent to  $66.3$  per cent. When diluted with water the official acid should yield no indications of lead, copper, arsenic, calcium, potassium, sodium, ammonium, chlorides, or nitrates, and only slight traces of iron or sulphates. Diluted with five or six times its bulk of water it is not precipitated by solution of albumin, indicating absence of metaphosphoric acid which coagulates albumin. Absence of both meta- and pyro-phosphoric acids is

also shown by adding tincture of ferric chloride and setting the mixture aside for several hours—no precipitation should occur. The presence of those two acids may be due to insufficient boiling when the anhydride is combined with water or to over concentration of the acid when removing excess of nitric acid used in the process of manufacture. Diluted with water and the mixture set aside no precipitate of silica (which is insoluble in the diluted acid) occurs. Absence of phosphorous acid is shown by diluting, adding mercuric chloride solution, and heating the mixture. No precipitate should be formed, but if phosphorous acid be present it reduces the mercuric to mercurous chloride which is insoluble. This reaction is effected by the  $\text{H}_3\text{PO}_3$  passing into  $\text{H}_3\text{PO}_4$ , water forming the medium by which the change is effected and chlorine being removed from the mercuric chloride by hydrogen, thus—

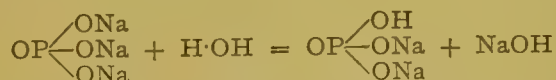


**Notes.**—Phosphoric acid is a tribasic acid, as shown by its constitutional

formula,  $\text{OP} \begin{array}{l} \diagup \text{OH} \\ \diagdown \text{OH} \end{array}$ . If the normal sodium salt, *i.e.*, the salt in which the whole of

the hydrogen is replaced by sodium,  $\text{Na}_3\text{PO}_4$  or  $\text{OP} \begin{array}{l} \diagup \text{ONa} \\ \diagdown \text{ONa} \end{array}$ , be dissolved in water,

there is a strongly alkaline reaction, due probably to dissociation of that phosphate, thus—



Even this di-sodium hydrogen phosphate  $\text{Na}_2\text{HPO}_4$  has an alkaline reaction (*vide* Sodii Phosphas), although it is an acid salt in constitution, *i.e.*, still contains replaceable hydrogen. The entrance of the two sodium atoms has, however, so weakened the acid character of the remaining hydrogen atom that it no longer responds like an acid to the indicators employed. The strength of phosphoric acid is not determined officially by titration with standard alkali, like hydrochloric and nitric acids, for example, because a sharp colour reaction to indicate the termination of the process is not readily obtained. This phenomenon is noticed with other polybasic acids, and is due to the varying facility with which the hydrogen atoms of such acid are successively replaced by bases.

## Acidum Phosphoricum Dilutum.

**Diluted Phosphoric Acid** is obtained by diluting 3 fluid ounces of concentrated phosphoric acid with water, so that the product measures one pint at  $15.5^\circ \text{C}$ . It contains 13.8 per cent. of  $\text{H}_3\text{PO}_4$ , corresponding to 10 per cent. of  $\text{P}_2\text{O}_5$ .

**Characters and Tests.**—Diluted phosphoric acid is a colourless liquid responding to the qualitative tests given under Acidum Phosphoricum Concentratum. Its specific gravity is 1.08. One gramme mixed with 0.5 gramme of lead oxide in fine powder should leave on evaporation a residue which, after it has

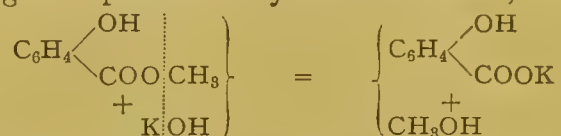


been heated to dull redness, weighs 0.6 gramme. The increase in weight is due to the  $P_2O_5$  derived from 1 gramme of diluted acid, which therefore contains 10 per cent. of  $P_2O_5$ , equivalent to 13.8 per cent. of  $H_3PO_4$ .

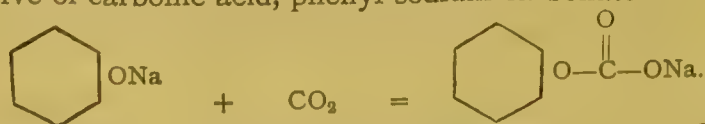
[Dose.—5 to 20 minims.]

## Acidum Salicylicum.

**Salicylic Acid**, or ortho-oxy-benzoic acid,  $C_6H_4(OH) \cdot COOH$ , is obtained from two sources, the two products being distinguished as “natural” and “artificial” salicylic acids respectively. The natural variety is so-called because it is derived from several naturally occurring essential oils which contain the methyl ester of salicylic acid. Methyl salicylate has been detected as a constituent in the oils distilled from over twenty different plants, but the two which serve as the chief commercial source of natural salicylic acid are the oils of wintergreen (*Gaultheria procumbens*) and sweet-birch (*Betula lenta*). Those consist of about 99 per cent. of methyl salicylate, the remaining one per cent. consisting of a hydrocarbon and traces of other bodies. To obtain salicylic acid the oils are saponified by boiling with potassium hydroxide solution, thus—



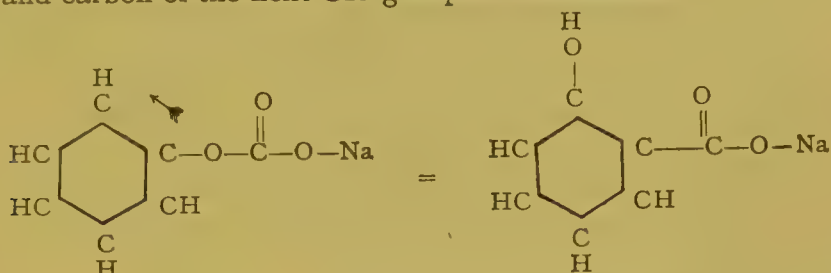
The operation is conducted in a vessel connected with a reflux condenser, and when saponification is complete the methyl alcohol may be separated by distillation from the solution of potassium salicylate. This methyl alcohol is one of the purest forms obtainable and is sold as “methyl alcohol from oil of wintergreen.” The potassium salicylate solution, when treated with hydrochloric acid, yields a crystalline precipitate of the sparingly soluble salicylic acid. Synthetic or “artificial” salicylic acid is obtained by the interaction of sodium carbolate and carbon dioxide under carefully regulated conditions of temperature and pressure. The process by which it is prepared is known as the “Kolbe synthesis,” from the name of the inventor. It is a general process for preparing the aromatic oxy-carboxylic acids from any given phenol. Ordinary phenol,  $C_6H_5 \cdot OH$ , gives, therefore,  $C_6H_4 \cdot OH \cdot COOH$ , oxy-benzoic acid. This being a di-derivative, may occur in the usual three isomeric varieties, and the ortho-variety is known as salicylic acid. In the original process of Kolbe the sodium phenate, prepared by adding a strong solution of sodium hydroxide to the calculated quantity of phenol, very carefully dried, was heated in a current of dry carbon dioxide at a temperature of  $110^\circ C.$ , increasing finally to  $200^\circ C.$  The first step is the entrance of  $CO_2$  into the phenol molecule, forming a derivative of carbonic acid, phenyl-sodium carbonate—



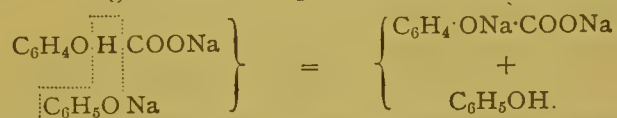
This is analogous to ordinary sodium carbonate,  $\text{NaO}-\overset{\text{O}}{\parallel}{\text{C}}-\text{ONa}$

one atom of sodium being replaced by the phenyl residue,  $C_6H_5$ . As the

temperature rises this is converted by intra-molecular re-arrangement into sodium salicylate. The oxygen atom connecting the carbon of the side chain with the benzene nucleus shifts its position and interpolates itself between the hydrogen and carbon of the next CH group of the nucleus.



The sodium salicylate so formed could not be isolated at once, according to the original process, because it reacted with more sodium phenate to give the basic sodium salicylate, with regeneration of phenol which distilled over—



Only half of the phenol was therefore converted into salicylate. In Schmitt's modification of the Kolbe process the reaction between the carbon dioxide and sodium phenate takes place under pressure. Under these circumstances the intra-molecular re-arrangement takes place as described and the further reaction—between the salicylate and a second portion of phenate—does not occur. Therefore, the whole of the phenol is finally obtained as sodium salicylate. It is interesting to note that if the temperature at which the reaction takes place be allowed to exceed 200° C. the atom of oxygen which shifts its position takes up the para position to the carboxyl group. The para-oxy-benzoate is also the chief product of the reaction if potassium carbolate be employed in place of the sodium compound. From the sodium salicylate the acid is prepared by dissolving the reaction-product in water and adding hydrochloric or sulphuric acid. The precipitate is collected, washed, and purified by recrystallisation.

**Characters and Tests.**—Salicylic acid forms distinct, prismatic, colourless crystals. Taste at first sweetish, then acid, leaving a burning sensation in the throat. Soluble in about 500 parts of cold water, 15 parts of hot water, 3 of alcohol (90 per cent.), 2 of ether, or 200 of glycerin. Its solubility in water is increased by the presence of ammonium citrate, sodium phosphate, or borax, probably owing to the alkaline reaction of aqueous solutions of those salts. A solution of sodium salicylate, not weaker than one per cent., obtained by dissolving the acid in solution of sodium hydroxide or carbonate, gives a yellowish brown precipitate of sparingly soluble uranium salicylate on the addition of uranium nitrate solution. This test distinguishes salicylates from carbolates and sulpho-carbolates, which do not form insoluble uranium compounds. The crystals should melt at 156° to 157° C., and below 200° C. they volatilise without decomposition. Ferric chloride gives with salicylic acid an intense violet, and in extremely diluted solution a reddish-violet, colour. Shaken up with a small proportion of water, the mixture filtered, and the



filtrate evaporated in a watch glass or white porcelain dish, there remains a white residue of salicylic acid if the acid be pure. Traces of unidentified organic impurities may reveal themselves here by yielding a residue with a buff-tinted fringe. Salicylic acid dissolves in cold strong sulphuric acid, forming a colourless derivative, sulpho-salicylic acid. This test will detect many possible organic impurities, which are charred by strong sulphuric acid. Phenol may be detected by dissolving the acid in excess of cold sodium carbonate solution, thus forming sodium salicylate. Since phenol does not combine with the alkaline carbonates, but only with the hydroxides, it may be extracted from the aqueous liquid by agitation with ether. After separation, the ethereal layer, if allowed to evaporate spontaneously, will leave any phenol as a liquid residue, which may be identified by its odour and the application of suitable tests.

**Notes.**—Artificial salicylic acid, when pure, is chemically identical with the acid from natural sources. The artificial acid formerly produced contained an appreciable quantity of impurities which were said to produce unpleasant effects when the salicylic acid containing them was administered in large doses. Those impurities were found to be the para-oxy-benzoic acid, whose appearance is due to the causes mentioned under the method of preparation, and some homologues of salicylic acid, produced from homologous phenols present in the carbolic acid employed, since commercial carbolic acid is never absolutely pure. Those homologues are chiefly the ortho-, meta-, and para-cresol,  $C_6H_4(CH_3)(OH)$ . The Kolbe process, as already mentioned, constitutes a general process for the preparation of oxy-carboxylic acids from phenols; all these homologous phenols consequently yield the corresponding carboxylic acids, which may therefore occur as impurities in salicylic acid. The three acids corresponding to the cresols are known as cresotic acids,  $C_6H_3(CH_3)(OH)(COOH)$ , and the ortho- and para- varieties were said to be the chief constituents to which the objectionable effects were due. Owing to improvements in manufacture and further purification, artificial salicylic acid can, at the present time, be obtained practically pure, and is used almost to the exclusion of the "natural" acid on account of the high price of the latter. It should be noted that the name salicylic acid applies only to the ortho-oxy-benzoic acid. The isomeric meta- and para-oxy-benzoic acids are well known; they differ from salicylic acid in giving no violet colour with ferric chloride, and in not volatilising with steam. The melting point of the acid is a most valuable criterion of purity, since the presence of small traces of the impurities referred to causes an appreciable depression in the observed temperatures. [*Dose.*—5 to 20 grains.]

## Acidum Sulphuricum.

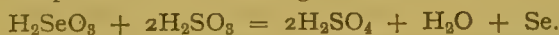
**Sulphuric Acid** is produced by the combustion of sulphur or pyrites, and the oxidation and hydration of the resulting sulphurous anhydride by means of nitrous and aqueous vapours. It should contain about 98 per cent. of real  $H_2SO_4$ . The formation of sulphuric acid is the outcome of some complicated reactions which cannot be simply represented by equations, and whose exact nature probably varies according to the conditions under which the reactions take place and to

the proportions of the reacting substances. The production of sulphuric acid is believed to be preceded by the formation of nitrosyl-sulphuric acid or "chamber crystals," which is decomposed by the water in the leaden chambers, with production of sulphuric acid and regeneration of nitric oxide and peroxide; those oxides take up oxygen from the air and form more nitrosyl-sulphuric acid, thus starting again the same cycle of reactions.

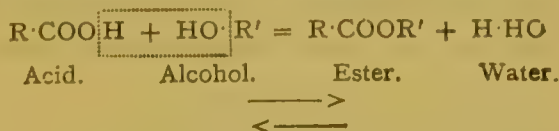
**Characters and Tests.**—Sulphuric acid is a colourless, corrosive, intensely acid liquid of oily consistence, which evolves much heat on the addition of water. Specific gravity, 1·843. It yields when diluted with water and neutralised the reactions characteristic of sulphates. One gramme diluted with 20 or 30 C.c. of water should require for neutralisation 20·1 C.c. of normal sodium hydroxide solution, thus—

$$\begin{array}{rcl} \text{H}_2\text{SO}_4 & + & \text{2NaOH} = \text{Na}_2\text{SO}_4 + \text{2H}_2\text{O} \\ \hline 97\cdot34 & & 2 \times 39\cdot76 \\ \text{1 C.c. N/1 NaOH solution} & = & 0\cdot04867 \text{ gramme H}_2\text{SO}_4 \\ \therefore \text{20}\cdot\text{1 C.c.} & \text{,,} & \text{,,} = 0\cdot978267 \text{ ,,} \text{ ,,} \\ & & = 97\cdot83 \text{ per cent.} \end{array}$$

It should yield no characteristic reactions with the tests for lead, copper, arsenium, selenium, iron, ammonium, chlorides, nitrites, nitrates, or sulphites. It should not yield more than 0·05 of solid residue on evaporation, showing absence of non-volatile mineral impurities generally. Hydrochloric acid, in which some sodium sulphite has been dissolved, when poured carefully upon an equal volume of sulphuric acid contained in a test tube so as to form a distinct layer, should not cause a red coloration at the junction of the two liquids, and no red precipitate should form on warming the tube. A red colour or precipitate obtained here indicates contamination with selenium compounds. Selenium is an element of the sulphur group, and sometimes occurs in the crude sulphur compounds used in the manufacture of sulphuric acid. Like sulphur, it forms a dioxide,  $\text{SeO}_2$ , and that dissolves in water to form the corresponding selenious acid,  $\text{H}_2\text{SeO}_3$ . The test depends upon the reduction of that acid by means of sulphurous acid in presence of hydrochloric acid ( $\text{Na}_2\text{SO}_3 + 2\text{HCl} = \text{H}_2\text{SO}_3 + 2\text{NaCl}$ ); the element selenium is deposited as a red precipitate, the sulphurous acid being oxidised to sulphuric acid, thus—



**Notes.**—The name "oil of vitriol" was given to sulphuric acid on account of its oily consistence and its preparation in former times by the distillation of iron sulphate, then known as "green vitriol." Sulphuric acid is an important reagent on account of its affinity for water. This property is utilised, for example, in the production of esters of organic radicals from alcohols and acids. The process of esterification proceeds to only a limited extent, owing to the production of water, which causes a reversal of the process. If R and R' stand for any radical the reaction may be written thus—





The arrows indicate that the reaction proceeds in either direction according to the proportions of the reacting substances and other conditions of the experiment. If sulphuric acid be present it combines with the water and the reaction proceeds continually from left to right with continuous production of the ester. Compare the notes on *Æther Aceticus*.

## Acidum Sulphuricum Aromaticum.

**Aromatic Sulphuric Acid**, sometimes known as Elixir of Vitriol, is produced by diluting 3 fl. ounces of sulphuric acid with  $29\frac{1}{2}$  fl. ounces of 90 per cent. alcohol, and adding  $\frac{1}{2}$  fl. ounce of spirit of cinnamon and 10 fl. ounces of tincture of ginger.

**Tests.**—Aromatic sulphuric acid should be of specific gravity 0.922 to 0.926. Titrated with standard alkali, its neutralising power should be equivalent to 13.8 per cent. of real  $\text{H}_2\text{SO}_4$ .

**Notes.**—A small amount of ethyl hydrogen sulphate is formed by the reaction between the alcohol and acid, and contributes to the aromatic odour of the preparation. [Dose.—5 to 20 minims.]

## Acidum Sulphuricum Dilutum.

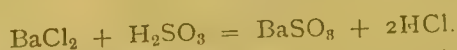
**Diluted Sulphuric Acid** is prepared by adding 1.65 fl. ounces of sulphuric acid to half-a-pint of water, and afterwards diluting with more water, so that the product shall measure one pint when cooled to  $15.5^\circ \text{C}$ .

**Tests.**—Diluted Sulphuric Acid should be of specific gravity 1.094. One gramme requires for neutralisation 2.8 C.c. of normal sodium hydroxide solution, corresponding to 13.65 per cent. of real  $\text{H}_2\text{SO}_4$ . [Dose.—5 to 20 minims.]

## Acidum Sulphurosum.

**Sulphurous Acid** is an aqueous solution containing 6.4 per cent. of  $\text{H}_2\text{SO}_3$ , corresponding to 5 per cent. of sulphurous anhydride,  $\text{SO}_2$ . The sulphurous anhydride may be obtained by burning sulphur in air or oxygen, or by boiling sulphuric acid with reducing agents, such as carbon, copper, or mercury.

**Characters and Tests.**—Sulphurous acid is a colourless liquid with a pungent sulphurous odour. Specific gravity, 1.025. It yields, when neutralised, the reactions characteristic of sulphites. It should give but a slight precipitate with solution of barium chloride, showing the absence of more than small quantities of sulphuric acid, into which sulphurous acid is converted by oxidation when its aqueous solution is long kept. Barium sulphite is insoluble in water, but is not precipitated on the addition of  $\text{BaCl}_2$  to solutions of the free acid, because  $\text{BaSO}_3$  is easily soluble in the free hydrochloric acid which is formed at the same time, thus—

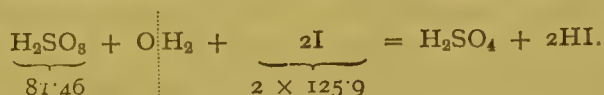


If solution of chlorine be first added, and then barium chloride, a copious

precipitate of barium sulphate will be obtained, because chlorine, in presence of water oxidises the sulphurous acid to sulphuric acid—



When evaporated, the sulphurous acid is decomposed with evolution of the anhydride, and no fixed residue is left. Titrated with iodine, 1 gramme of the official solution should decolorise 15.7 C.c. of decinormal iodine solution. The reaction on which the determination is based results in the oxidation of the sulphurous acid to sulphuric acid in presence of water, the iodine at the same time forming hydriodic acid—



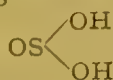
In order to completely realise this reaction, the reaction-mixture must be extremely dilute, containing not more than 0.05 per cent. of  $\text{SO}_2$ , because in stronger solutions the reaction is partially reversed. The official acid must therefore be diluted at least 100 times, and in order to avoid the oxidising effect of oxygen dissolved in this relatively large volume of water, it is necessary to boil and cool some distilled water before employing it for this dilution. Since 1000 C.c. of decinormal iodine solution contain 12.59 grammes of iodine, each cubic centimetre of the volumetric solution will be equivalent, according to the equation given above, to  $\frac{81.46}{10 \times 2 \times 1000}$  grammes  $\text{H}_2\text{SO}_3 = 0.004073$  gramme.

Therefore,

$$\begin{aligned} 15.7 \text{ C.c. N/10 Iodine solution} &= 0.004073 \times 15.7 \text{ grammes } \text{H}_2\text{SO}_3 \\ &= 0.06395 \quad \quad \quad \text{''} \quad \quad \quad \text{''} \end{aligned}$$

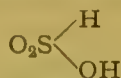
and 0.06395 gramme of  $\text{H}_2\text{SO}_3$  in 1 gramme is equivalent to 6.395 per cent. The termination of the reaction may be known by the persistent brown colour produced as soon as the iodine is in excess. The indication is rendered more delicate by the addition of starch mucilage, since the colorimetric power of the blue iodide of starch is much greater than the brown of the equivalent quantity of free iodine.

**Notes.**—Sulphur dioxide is met with in commerce as liquefied gas in sealed metal canisters and syphons. The gas condenses to a liquid at  $-10^\circ \text{C}$ . under normal atmospheric pressure or at  $15^\circ \text{C}$ . under a pressure of three atmospheres. The constitutional formula for sulphurous acid may be one of the following, which are distinguished as symmetrical and unsymmetrical—



(1) Symmetrical.

or



(2) Unsymmetrical.

Organic sulphites are known whose behaviour corresponds with formula (1) because by saponification the two alkyl residues replacing the hydrogen atoms are easily removed. Sulphurous acid and metallic sulphites are believed to have the constitution expressed by formula (2). In this connection it is interesting to note that whereas sulphuric acid,  $\text{O}_2\text{S} \begin{array}{l} \text{OH} \\ \text{OH} \end{array}$ , is not reduced by nascent hydrogen in the cold, sulphurous acid readily yields  $\text{H}_2\text{S}$ , thus—





The faculty of thus yielding  $H_2S$  by reduction seems to be characteristic of all sulphur compounds which contain an atom of sulphur directly connected with hydrogen as shown in formula (2). [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

## Acidum Tannicum.

**Tannic Acid**,  $C_{14}H_{10}O_9$ , is found in galls to the extent of 60 to 70 per cent. It is obtained by exhausting the coarsely powdered galls with ether containing a little alcohol and water. The ethereal liquid is then shaken with about one-fourth its volume of water; the mixture separates on standing into two layers, an upper ethereal fluid which retains the bulk of the colouring matter, etc., and a lower aqueous layer which contains nearly all the tannic acid. The lower layer is separated and evaporated at a low temperature to obtain the tannic acid. The process is founded upon the great solubility of tannic acid in ether saturated with water, and its extraction from the ether when more water is subsequently added so as to form a separate aqueous layer, which again extracts the tannic acid from the water-saturated ether. The latter retains a number of other substances which are extracted from the galls. Tannic acid is almost insoluble in pure ether, *i.e.*, ether free from water and alcohol. The official formula for the acid should be corrected by omitting the water of crystallisation.

**Characters and Tests.**—Tannic acid is a light brownish powder consisting of thin glistening scales, with a characteristic odour, astringent taste, and acid reaction; it is soluble in 1 part of water or alcohol (90 per cent.) and in 1 part of glycerin. The acid is precipitated from its aqueous solutions by many acids and salts (sulphuric acid and sodium chloride for example) by a process which resembles the salting out of soap, *i.e.*, the tannic acid is rendered insoluble in the solution formed by the added salt or acid and the water. Tannic acid also forms insoluble metallic tannates with most of the heavy metals. Its aqueous solution precipitates (1) with solutions of gelatin (isinglass), this reaction forming the basis of the use of tannic acid in making leather from hides and skins, (2) with albumin, which property partly explains the action of tannic acid in arresting hæmorrhage by the formation of a styptic clot with the proteids (albumin) of blood, (3) with alkaloids, which nearly all form insoluble tannates, hence the use of tannic acid as an antidote in poisoning with alkaloids, and (4) with tartarated antimony. The last reaction is given by most, but not all, of the naturally existing tannic acids.

**Notes.**—The term "tannin" really includes a large number of bodies having an astringent taste and certain points of analogy in their reactions and constitution. In the Pharmacopœia the term is used in a restricted sense to indicate the variety more exactly known as gallo-tannic acid. The group of tannins may be divided broadly into two classes:—

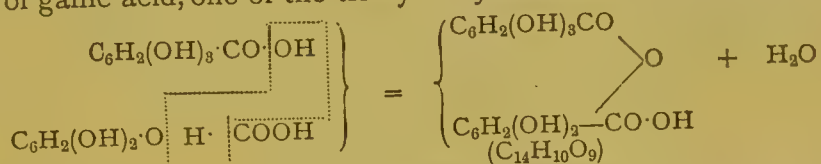
(1) Those which give a blue coloration with iron salts, and are derivatives of pyrogallol, *e.g.*, gallo-tannic acid.

(2) Those which give a green colour with iron salts, and are derived from catechol, *e.g.*, catechu-tannic acid and kino-tannic acid. Some of the tannins exist naturally as glucosides, which may be regarded as esters of

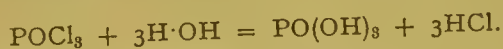
glucose, formed by elimination of water from the carboxyl group of the acid and one of the hydroxyl groups of the glucose—



Gallo-tannic, however, is not a glucoside but a condensation product of two molecules of gallic acid, one of the tri-hydroxy-benzoic acids,  $\text{C}_6\text{H}_2(\text{OH})_3\text{COOH}$ .



When gallo-tannic acid is boiled with acidulated water, hydrolysis occurs (*vide* method of preparing Acidum Gallicum), a molecule of water being taken up, with formation of gallic acid. The reverse process, *i.e.*, the formation of tannic acid from gallic acid can be carried out by heating the gallic acid with certain reagents, like phosphorus oxychloride, which facilitate the elimination of the water. Such reagents react with the water as fast as it is liberated, forming other compounds which do not interfere with the progress of the reaction, thus—



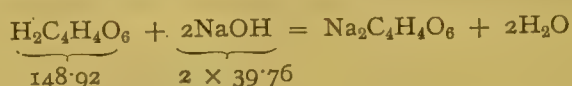
The tannins all precipitate with gelatin and albumin solutions. The alkaloidal tannates are also very insoluble in water and on this account tannic acid is sometimes used for separating alkaloids from solutions containing other substances not precipitated by tannic acid. The alkaloids may be recovered from such precipitates by digesting them with fresh moist lead hydroxide, which combines with the tannic acid; from the dried magma the free alkaloid may then be extracted by treatment with suitable solvents. [Dose.—2 to 5 grains.]

## Acidum Tartaricum.

**Tartaric Acid**,  $\text{H}_2\text{C}_4\text{H}_4\text{O}_6$ , is one of the most widely-distributed organic acids, occurring naturally in many fruits. Its commercial source is the argol or crude tartar deposited from grape juice during the fermentation which leads to the production of wine. This argol consists chiefly of acid potassium tartrate and calcium tartrate, which are deposited in proportion as the alcoholic strength of the fermenting juice increases, owing to their lesser solubility in alcohol than in water. The crude argol is first boiled with chalk, and then calcium chloride is added so as to convert all the tartrates present into insoluble calcium tartrate. This is washed, boiled with dilute sulphuric acid, and, after separation of the sparingly soluble calcium sulphate, the filtrate containing the tartaric acid is evaporated and crystallised. The constitutional formula given in the Pharmacopœia applies equally well to the four isomeric varieties of dioxysuccinic acid mentioned below. The tartaric acid and acid tartrate of potassium found in the vegetable kingdom consist almost entirely of the dextro-rotatory variety, the others being chiefly obtained by artificial or synthetic means.



**Characters and Tests.**—Tartaric acid forms colourless, monoclinic prisms, of strongly acid and sweetish taste. It is soluble in less than its own weight of water, and in less than three times its weight of 90 per cent. alcohol. Neutralised by sodium or potassium hydroxide, its solution affords the reactions characteristic of tartrates. An aqueous solution rotates the plane of a ray of polarised light to the right. One gramme of tartaric acid, dissolved in water, should require 13.3 C.c. of normal sodium hydroxide solution for neutralisation; phenol-phthalein should be used as indicator.

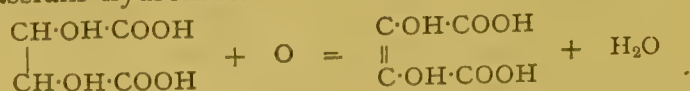


Each cubic centimetre of N/1 soda solution is, therefore, equivalent to  $148.92 \div (2 \times 1000)$  grammes of tartaric acid = 0.07446 gramme. Therefore,

$$\begin{aligned} 13.3 \text{ C.c. N/1 NaOH solution} &= 0.07446 \times 13.3 \text{ grammes H}_2\text{C}_4\text{H}_4\text{O}_6 \\ &= 0.9903 \quad \quad \quad \text{,,} \quad \quad \quad \text{,,} \\ &\text{or } 99.03 \text{ per cent. pure.} \end{aligned}$$

Tartaric acid should give no decided reaction with the tests for copper, arsenium, iron, potassium, sodium, oxalates, or sulphates, and should yield no reaction for lead when examined by the test described under "Acidum Citricum." When incinerated with free access of air, it should not yield more than 0.1 per cent. of ash, thus showing freedom from more than traces of fixed mineral impurities.

**Notes.**—Tartaric acid furnishes one of the most interesting examples of physical isomerism. In order to comprehend fully the influence of the asymmetric carbon atom in producing physical isomerism, two tetrahedra should be constructed by joining four equilateral triangular pieces of cardboard by means of gummed paper. The four projecting points of the tetrahedra may be coloured red, blue, green, and yellow, to represent the four different elements or groups combined with the carbon atom. With those models for reference, there should be no difficulty, after carefully reading the section on stereo-isomerism in a text-book, in comprehending the constitution of dextro, lævo, meso, and racemic tartaric acids. Note particularly that the optical inactivity of the meso and racemic acids is produced by internal and external compensation respectively. The last test for tartrates given in the B.P. Appendix (p. 429) depends upon the formation, by oxidation, of a derivative—di-oxymaleic acid—which gives the blue colour with potassium hydroxide.



The oxidising agent is hydrogen peroxide, and the ferrous sulphate acts as a carrier of oxygen between the peroxide and the tartaric acid. The importance of the test lies in the fact that none of the allied organic acids (citric, malic, lactic, etc.) produce this particular substance when oxidised. Hence it serves to detect small quantities of tartaric acid in presence of citric acid—a procedure which is otherwise somewhat difficult. The other test for tartaric acid in citric acid (*vide* tests for Acidum Citricum, B.P.) applies also to metallic particles, and to reducing agents generally. The blue colour is due

to the reduction of the molybdate to a lower oxide. The metallic particles would be derived from the utensils used in the process of manufacture, and they act as reducing agents in the acid solution by virtue of the hydrogen they are capable of liberating. The test for the detection of lead in both tartaric and citric acids, as described in the Pharmacopœia, depends upon the production of black lead sulphide. Addition of a saturated aqueous solution of sulphuretted hydrogen is said to give more delicate indications of traces of lead than are afforded by merely allowing sulphuretted hydrogen gas to bubble through aqueous solutions of the acid. [Dose.—5 to 20 grains.

## Aconiti Radix.

**Aconite Root** is obtained from *Aconitum Napellus*, Linné (N.O. Ranunculaceæ), a perennial herbaceous plant which grows abundantly in the mountainous districts of Europe, Asia, and North America. The fresh leaves and flowering tops of aconite were formerly used in medicine, but the dried root alone is now official. It is directed that the root should be collected in the autumn from plants cultivated in Britain, the object being to insure that it shall always be grown under uniform conditions and used only when it has attained perfection, thus guarding against variation in the strength of the drug. When the plant is in full growth, there are usually two roots joined together, the older one supporting the stem, and the younger root being destined to produce the stem of the following year. About October, when the old stem has died down, the young root has attained its maximum development and should be collected before the bud from which the new stem would naturally proceed has begun to develop. When the plant is in flower the new root is formed, but only half grown. Old roots must be rejected. After collection, the roots are washed, freed from rootlets, and carefully dried, either entire or after being sliced longitudinally so as to facilitate drying. German aconite root is said to be richer in alkaloid than English.

**Characters.**—Aconite root resembles an elongated cone in shape, and varies usually from 5 to 10 Cm. in length; it measures from 12 to 18 Mm. in diameter and tapers very gradually downwards. Externally, the root is dark brown in colour, usually wrinkled longitudinally, and marked with the scars and bases of broken-off rootlets; it should also be crowned with scaly leaves enclosing an undeveloped bud. It breaks with a short fracture, and appears whitish internally, as it consists mainly of uniform parenchymatous cells loaded with starch granules. Hollow or spongy roots must be rejected, as their reserve material has been exhausted by the development of the flowering stem. The retention of any portions of stem also indicates that the root is old or has not been collected at the proper season, since the old stem must have died down and entirely disappeared by the time the new root attains its maximum development—being then plump and full of starch—and the new stem should not have begun to develop. If the root be transversely cut and the fresh surface examined with a lens, the stellate centre is seen to consist of large-celled, polyhedral parenchyma, containing an abundance of starch grains; it is



divided from the thick parenchymatous cortex by a narrow irregular line—the cambial zone—which gives it the appearance of a star with five to seven rays, and at each angle of the figure thus formed occurs a small vascular bundle. No trace of cuticle is found except at the tips and adjoining parts of the roots; elsewhere it is replaced by brown parenchymatous cells which have formed part of the primary cortex. The fresh root has only a very faint earthy odour, which has been incorrectly described as pungent or radish-like; there is, however, the faintest possible momentary irritation when the root is first smelled. The taste is at first slight, but a persistent sensation of tingling and numbness soon manifests itself in the mouth, the effect being due to aconitine, the extremely poisonous active principle of the drug. Ash-yield, about 5 per cent.

**Notes.**—The distinctive characters of aconite root are its elongated conical shape, starchy interior, stellate cambium, and the persistent tingling produced on tasting the root. On account of the extremely poisonous nature of the drug, it is necessary that the potency of its preparations should be regulated as far as possible by growing and collecting the root under uniform conditions. The official description excludes German and Japanese aconite roots, also English roots which are immature or exhausted of their reserve material. The chief constituent of the root is the extremely poisonous crystalline alkaloid aconitine (acetyl-benzoyl-aconine), which is believed to be present in combination with aconitic acid; other constituents are the amorphous, bitter, non-toxic alkaloids picraconitine (benzoyl-aconine) and aconine, together with resin, fat, sugar, and starch. The quantity of aconitine in the root is supposed to be greatest in the autumn, but that point has not yet been definitely established; the total alkaloid present in aconite root of good quality varies from 0.5 to 1.5 per cent., about 0.3 to 0.5 per cent. consisting of aconitine. A standard of 0.4 per cent. has been suggested.

## Aconitina.

**Aconitine** or acetyl-benzoyl-aconine is the chief alkaloid found in the root of *Aconitum Napellus*, Linné, in which it is supposed to exist in combination with aconitic acid, and it is the only alkaloidal constituent of that drug which has been obtained in crystalline form. The alkaloid can be extracted by exhausting the ground root with an alcoholic solution of tartaric acid and—after removal of resin, etc.—precipitating the aconitine from the solution in which it exists as tartrate, by the addition of potassium carbonate. The impure aconitine so obtained may be purified by dissolving it in ether, adding an aqueous solution of tartaric acid, precipitating the base with sodium carbonate, again dissolving it in ether and, finally, allowing it to crystallise from the ethereal solution. Further purification may be effected by converting the aconitine into hydrobromide, decomposing that salt—after recrystallisation—with sodium carbonate, and finally recrystallising the precipitated alkaloid from ether. Crystalline aconitine is officially stated to have the formula  $C_{33}H_{45}NO_{12}$ , but  $C_{34}H_{47}NO_{11}$  or  $C_{33}H_{47}NO_{11}$  is probably more correct. The alkaloid is intensely poisonous, its extreme toxic power, as compared with other aconine derivatives, being connected in some way with the presence of the acetyl radical in its molecule.

**Characters and Tests.**—Aconitine occurs in colourless, hexagonal prisms of the rhombic system, having three axes of unequal length at right angles to each other, as in the case of potassium bicarbonate, chromate, and sulphate. The crystals melt at  $189^{\circ}$  to  $190^{\circ}$  C.; if heated above that temperature they are decomposed, acetic acid being given off, and picraconitine (benzoyl-aconine) left. Aconitine is soluble in 35 parts of 90 per cent. alcohol, 1 part of chloroform, or 45 parts of ether, but is almost insoluble in water or in petroleum spirit. An alcoholic solution of the alkaloid turns the plane of a ray of polarised light to the right, whereas the salts of aconitine turn a similar ray to the left. The persistent tingling sensation characteristic of aconite root is perceived when a single drop of a solution containing not more than 0.1 per cent. of aconitine is placed on the tongue. Like the base itself, the salts of aconitine are crystalline; the hydrochloride melts at  $149^{\circ}$  C., and the hydrobromide at  $164^{\circ}$  C. An aqueous solution of aconitine, containing as little as 1 part in 4,000, and faintly acidulated with acetic acid, should yield a red or purple, crystalline precipitate, consisting of a sparingly soluble permanganate of the alkaloid, on adding a few drops of potassium permanganate solution. The reagent must be in very slight excess. The precipitate is readily distinguished from the similar ones given by cocaine, hydrastine, and papaverine, as cocaine and hydrastine permanganates are very readily dissolved by water, and hydrastine and papaverine permanganates are not crystalline; again, aconitine permanganate is not changed by the addition of a drop of bromine water to the mixture, whilst the cocaine salt turns a deep orange and that of hydrastine a bright yellow.

**Notes.**—The distinctive characters of pure aconitine are the shape of the crystals, the melting point, and the persistent tingling sensation produced when a single drop of a very dilute solution of the alkaloid is placed upon the tongue. When hydrolysed it yields acetic acid and picraconitine (benzoyl-aconine), and the latter in turn yields benzoic acid and aconine. Both picraconitine and aconine are amorphous and non-poisonous. Pseudoaconitine is a poisonous crystalline alkaloid (m.p.  $201^{\circ}$  C.), obtained from *Aconitum ferox*. Like aconitine, it is readily soluble in alcohol and chloroform, less readily in ether, and only slightly soluble in water. It can be distinguished from aconitine by the beautiful purple-red colour produced on adding a solution of potassium hydroxide in absolute alcohol to the yellow residue left on moistening a small quantity of the alkaloid with fuming nitric acid and heating to dryness. Aqueous or alcoholic solutions of aconitine tend to decompose unless slightly acidified with hydrochloric acid, and solutions of the more stable crystallised aconitine nitrate are to be preferred.

## Adeps.

**Lard** is the purified abdominal fat of the hog, *Sus scrofa*, Linné (Order Ungulata). The flat leafy masses known as "flare" are well washed with water to free them from any salt that may have been used as a preservative; the external membranes are then removed as far as possible, and the fat is freed



from moisture by exposure to the air for some hours, the effect of so drying it being to render it less liable to become rancid and mouldy. The fat is next cut into small pieces and beaten in a mortar, or otherwise suitably treated, until the membranous vesicles are completely broken, and the fat is entirely released. The resulting mass is then heated in a vessel surrounded by warm water, at a temperature not exceeding  $57^{\circ}\text{C.}$ , and when the fat is completely melted it is separated from the membranous matter by straining through linen or fine flannel. If heated to a higher temperature than that specified it will acquire an unpleasant odour and taste. After straining, the lard is stirred gently till cool to prevent granulation from the crystallisation of stearin and palmitin, but care must be taken to prevent the introduction of air into the melted fat, as that would tend to promote rancidity. If the purified fat thus obtained be subjected to pressure, a certain amount of oil (lard oil or lard olein) is removed and indurated lard (*Adeps Induratus*) is the result.

**Characters and Tests.**—Lard should be soft, white, and of a uniform consistence, fusing at  $38^{\circ}$  to  $41^{\circ}\text{C.}$ , and forming a clear liquid at a somewhat higher temperature. It should have only a slight fatty odour (indicating freedom from rancidity), be neutral to litmus (test for free fatty acids), and dissolve entirely in ether. The presence of common salt may be detected by boiling the lard with water, filtering when cool, acidifying the aqueous filtrate with nitric acid, and adding a few drops of silver nitrate solution, which gives the white curdy precipitate characteristic of chlorides. A clean platinum wire dipped into the liquid will indicate the presence of sodium by imparting a strong yellow coloration to the blue flame of a spirit lamp or a Bunsen burner. If starch has been added to whiten the lard, the cooled filtrate will be coloured blue on adding a little iodine solution. Cotton-seed oil is frequently present in American lard, and may be detected by Becchi's test: Heat 5 C.c. of the melted fat on a water-bath with a solution of 0.05 gramme of silver nitrate in 5 C.c. of 90 per cent. alcohol, to which one drop of nitric acid has been added. After heating for five minutes, shake vigorously. The silver salt is reduced by cotton-seed oil, and the fatty layer which separates on standing is then of a dark colour. The limit of acidity is indicated by a permanent red colour being produced on dissolving 10 grammes of lard in a mixture of equal volumes of chloroform and 90 per cent. alcohol, adding two drops of phenol-phthalein solution, and then 0.2 C.c. of volumetric solution of sodium hydroxide.

**Notes.**—Pure lard consists approximately of 40 per cent. of stearin and palmitin, mixed with 60 per cent. of olein. It should dissolve in 22 parts of ether and 16 of oil of turpentine, and requires about 20 per cent. of potassium hydroxide to effect complete saponification. Its specific gravity at  $15^{\circ}\text{C.}$  is about 0.934 to 0.938 when fresh, but varies more widely according to age. American lard usually begins to melt below  $36^{\circ}\text{C.}$ , owing to the presence of an unduly large proportion of olein. As the excess of olein tends to separate, such lard should not be used for making ointments. Rancidity in lard occurs chiefly when the fat is exposed to light; it is due partly to hydrolysis and partly perhaps to oxidation, induced by the presence of fermentative organisms. If any water be present in lard a clear solution will not be formed when the fat is dissolved in chloroform. It

should be noted that Becchi's test alone does not afford conclusive evidence of the presence of cotton-seed oil in lard, as pure lard which has been exposed to the air will give the same reaction, while cotton-seed oil which has previously been heated fails to give it. A better test is that of Bevan, a decided pink coloration being given when 3 grammes of lard, containing as little as 1 per cent. of cotton-seed oil, is heated in a salt bath, for about half an hour, with 1 C.c. of amylic alcohol and 1 C.c. of a 1 per cent. solution of sulphur in carbon disulphide. Note that the titration for free acid, which is found beyond the official limits in rancid lard, is conducted in chloroform-alcohol solution, since water does not appreciably dissolve either lard or its free fatty acids. Unless the fatty acids are in solution, the reaction does not take place readily between the acids and alkali, and a satisfactory indication of the end of the reaction is not obtained.

### Adeps Benzoatus.

**Benzoated Lard** is best prepared by melting lard, 500, on a water-bath, adding powdered benzoin (preferably the Sumatra variety), 15, and heating for one hour, with constant stirring. The residue of the benzoin is then removed by straining, and granulation prevented by stirring the lard until cold.

**Notes.**—During digestion the lard extracts the benzoic acid and other aromatic constituents from the benzoin, and the presence of those antiseptic bodies inhibits the growth of the organisms to whose development the rancidity of stale lard is partly due.

### Adeps Lanæ.

**Wool Fat** is the purified cholesterin-fat of the wool of the sheep, *Ovis aries*, Linné (Order Ungulata), and consists of a mixture of varying composition, containing fatty alcohols—cholesterol, iso-cholesterol, etc., together with esters of those alcohols. Sheep's wool may contain as much as 30 per cent. of fat, but usually it contains only from 10 to 15 per cent. The fat is readily extracted by simply kneading the wool with water; it forms an emulsion with the water and, on heating, separates as a distinct layer at the surface of the liquid. It may be purified by repeated treatment with water in a centrifugal machine, or by some other suitable process, and can be freed entirely from water by heating until its weight is constant. The anhydrous fat or lanolin is capable of incorporating 25 per cent. more than its own weight of water.

**Characters and Tests.**—Wool fat is a yellowish, tenacious, unctuous substance, with a slight but peculiar odour; its melting point should be about 40° C. Its saponification equivalent is equal to about 9 to 10 per cent. of potassium hydroxide. The fat dissolves readily in ether or in chloroform, but is less soluble in alcohol; 1 gramme requires 75 C.c. of boiling 90 per cent. alcohol to dissolve it "almost completely," and the greater part of the fat separates in flocks on cooling. When incinerated with free access of air, wool fat should not leave more than 0.3 per cent. of ash, and that should not be alkaline to litmus, thus indicating that the fat has been freed from the soap



used in washing the wool. The limit of acidity is indicated by a permanent red colour being produced on dissolving 10 grammes of wool fat in 25 C.c. of ether, adding 2 drops of phenol-phthalein solution and then 0.1 C.c. of volumetric solution of sodium hydroxide. A solution of the fat in chloroform acquires a purple-red colour when poured gently over the surface of strong sulphuric acid; this reaction is characteristic of cholesterol. Absence of particles of wool and other nitrogenous animal matter is indicated by the absence of ammoniacal odour when the fat is heated with sodium hydroxide solution.

**Notes.**—Cholesterol, the most prominent constituent of wool fat, is a monatomic alcohol,  $C_{25}H_{43}OH$ , of unknown constitution, which exists partly free and partly in the form of stearate and palmitate. The fat also contains a small quantity of ordinary glycerides; if it be saponified with alcoholic potash, and the alcohol be removed by evaporation, the resulting soap can be dissolved in water. The cholesterol can be extracted from the soap solution by agitation with ether and subsequent separation and evaporation of the ethereal layer, characteristic scaly crystals of cholesterol being left.

## Adeps Lanæ Hydrosus.

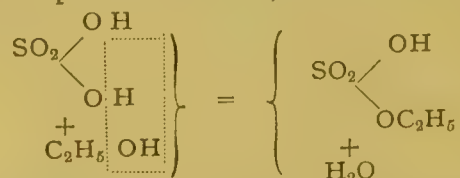
**Hydrous Wool Fat, or Lanolin,** is prepared by triturating wool fat, 7, in a warm mortar, with distilled water, 3, added gradually.

**Characters and Tests.**—Hydrous wool fat should be of a yellowish-white colour and free from rancid odour. When heated on a water-bath, it should separate into an upper oily layer and a lower aqueous layer, 10 grammes, so treated and stirred until the weight is constant, yielding not less than 7 grammes of anhydrous wool fat.

**Notes.**—Hydrous wool fat is capable of incorporating about half its weight of water and makes an excellent ointment basis when mixed with an equal weight of soft paraffin. The water present in hydrous wool fat can be approximately determined by dissolving 10 grammes in 10 C.c. of chloroform and measuring the water which separates.

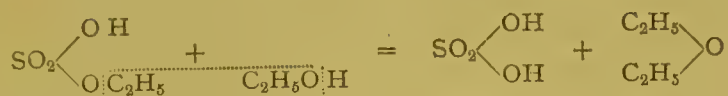
## Æther.

**Æther** may be prepared by mixing 5 of 90 per cent. alcohol with 9 of strong sulphuric acid. This mixture is then heated to about  $140^{\circ}C.$ , and a slow continuous stream of alcohol admitted, the rate of admission of alcohol and the further application of heat being so adjusted that the temperature of the boiling mixture, registered by means of a thermometer dipping into the liquid, is maintained between  $130^{\circ}$  and  $150^{\circ}C.$  By the first addition of alcohol to the acid ethyl hydrogen sulphate is formed, thus—



When more alcohol is added, under the conditions described, it reacts with the

ethyl hydrogen sulphate, forming ethyl oxide and regenerating sulphuric acid, thus—



At the temperature of the reaction the ether distils over, accompanied by some of the water, as well as alcohol which escapes the reaction. The re-formed sulphuric acid is then able to react again with alcohol because it does not distil over, owing to its boiling point being so much above  $150^\circ \text{C}$ . In this way, a given quantity of sulphuric acid is enabled to react with about ten times its weight of alcohol. Subsequently the formation of ether rapidly diminishes from two causes: (1) the accumulation of water formed by the first reaction, which reduces the concentration of the sulphuric acid below that necessary for the formation of ethyl hydrogen sulphate, and (2) secondary reactions between the acid and alcohol. The progress of those secondary reactions is rendered evident by the blackening of the reaction-mixture, which is due to carbonisation of the alcohol. By this means some of the sulphuric acid becomes reduced to sulphurous acid and, consequently, sulphurous anhydride ( $\text{SO}_2$ ) appears among the products accompanying the ether, alcohol, and water. The distillate is next shaken with water and alkali (chalk, lime, or sodium carbonate), the sulphurous acid being thus removed as sulphite, most of the alcohol being also removed. The layer of ether which separates is afterwards carefully redistilled. The rectified product contains about 92 per cent. by volume of ethyl oxide, the remaining 8 per cent. consisting of alcohol and water. Ether was formerly known as sulphuric ether because of the fact that sulphuric acid was used in its preparation.

**Characters and Tests.**—Ether is a colourless, mobile liquid with a strong and characteristic odour; it is very volatile and inflammable, its vapour mixed with air forming an explosive mixture. Ether vapour is about two and a-half times heavier than air. Ether is miscible in all proportions with alcohol, chloroform, and fixed or volatile oils. If 100 volumes be agitated with an equal volume of water in a graduated cylinder, and the mixture allowed to separate, the upper ethereal layer should measure not less than 90 volumes. If the ether contain more alcohol than is allowed by the official constants this alcohol passing into the aqueous layer will enable it to dissolve more than 10 volumes of ether and the upper layer will show a corresponding diminution. The boiling point of pure ethyl oxide is  $34.5^\circ \text{C}$ .; the presence of alcohol and water raises the boiling point, but the official ether should boil below  $40.5^\circ \text{C}$ . and not lower than  $34^\circ \text{C}$ ., thus excluding methyl oxide. The water and alcohol also increase the density, but the specific gravity should not be higher than 0.735. It should evaporate without residue and have no action on solution of litmus, showing that it has been freed from acid by rectification. Many organic impurities produced in the process of manufacture and not separated by rectification, or arising by decomposition on keeping, are detected by the charring which is produced when the impure ether is added drop by drop to strong sulphuric acid kept cold during the addition.



**Notes.**—The action of sulphuric acid on excess of alcohol (as in making ether) should be compared with the action of alcohol on excess of sulphuric acid. In both cases ethyl hydrogen sulphate is first formed, thus—



When excess of alcohol is present, it reacts with the ethyl hydrogen sulphate to form ether and sulphuric acid, thus—



On the other hand, when excess of sulphuric acid is present the mixture may be heated to a higher temperature before ebullition commences, and at this higher temperature the ethyl hydrogen sulphate is decomposed, ethylene and sulphuric acid being formed, thus—



Commercial methylated ether, prepared from methylated spirit, contains some methyl oxide, derived in an analogous manner from the methyl alcohol contained in the wood naphtha used in methylation, and some methyl-ethyl

oxide  $\begin{matrix} \text{CH}_3 \\ \text{C}_2\text{H}_5 \end{matrix} \rangle \text{O}$ , which arises from the action of methyl alcohol on ethyl hydrogen sulphate, or ethyl alcohol on methyl hydrogen sulphate. Methyl oxide is a gas at ordinary temperatures, its boiling point being  $-23^\circ \text{C}$ ., while methyl-ethyl oxide boils at  $11^\circ \text{C}$ ., hence methylated ether begins to boil at a lower temperature than pure ether (ethyl oxide). It should be noted that although ether is a very light fluid its vapour is very much heavier than air. The molecular weight of ether (*i.e.*, the relative weight of its molecules in the state of gas, compared to molecules of the standard—hydrogen as 2) is 73.52 [ $(\text{C}_2\text{H}_5)_2\text{O} = 73.52$ ]. By Avogadro's hypothesis equal volumes of gases at the same temperature and pressure contain the same number of molecules. Now the molecule of ether (mol. wt. 73.52) is 36.76 times heavier than the hydrogen molecule (mol. wt. 2), and the vapour density of ether is 36.76. Since air is 14.44 times heavier than hydrogen (as determined directly by weighing known volumes), ether vapour will be rather more than  $2\frac{1}{2}$  times  $\left(\frac{36.76}{14.44}\right)$  heavier than air.

[Dose.—10 to 30 minims (repeated); 40 to 60 minims (single).]

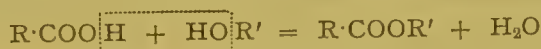
## Æther Aceticus.

**Acetic Ether** is a liquid composed chiefly of ethyl acetate,  $\text{CH}_3\text{COOC}_2\text{H}_5$ , with small quantities of ethylic alcohol, water, and other substances. It is obtained by distilling a mixture of ethylic alcohol, dried sodium acetate, and sulphuric acid. The distillate contains ethyl acetate, alcohol, water, and some acetic acid. It is shaken with dried potassium carbonate, which withdraws the acetic acid as potassium acetate together with most of the water. After decantation the liquid is submitted to fractional distillation, and the portion coming over between about  $74^\circ$  and  $78^\circ \text{C}$ . will constitute the official acetic ether, the boiling point of pure ethyl acetate being  $77^\circ \text{C}$ .

**Characters and Tests.**—Acetic ether is a colourless liquid with a fragrant odour, and is soluble in all proportions in 90 per cent. alcohol, ether, or

chloroform. One part by weight dissolves in not less than 10 parts of cold water, greater solubility than this indicating the presence of an unduly large proportion of water or alcohol, which would increase its solubility. Specific gravity 0.900 to 0.905. It should be neutral to litmus solution, and should not be coloured when mixed with an equal volume of strong sulphuric acid. Filter-paper moistened with acetic ether should remain odourless when the liquid has evaporated, any odour indicating the presence of impurities of less volatile nature.

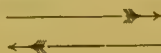
**Notes.**—The process for the preparation of acetic ether given in the Pharmacopœia is one of the general processes for the formation of esters, viz., the reaction between an acid and alcohol with elimination of water:—



The reaction, however, is not so simple as this equation indicates, because the accumulation of water retards the rate of formation, which finally stops when a certain proportion of ester has been formed. This condition of equilibrium is explained by assuming that the rate of formation of the ester is just equal to the rate at which it is saponified by the water produced, which leads to a reversal of the reaction represented by the equation above:—



The “limiting value,” *i.e.*, the proportion of alcohol capable of being converted into ester by the interaction of an acid and alcohol before the condition of equilibrium is attained, varies with the different classes of alcohols, being greatest for the primary and least for the tertiary alcohols. When molecular proportions of acetic acid and ethyl hydroxide are mixed and allowed to stand, the formation of ethyl acetate proceeds until 66 per cent. of the alcohol has been converted into ethyl acetate. If molecular proportions of ethyl acetate and water be mixed then the reverse change takes place, and proceeds until 34 per cent. (100—66) of alcohol has been formed and the mixture attains the same composition as before. Reversible reactions of this kind may be expressed in the following manner, the arrows indicating that the reaction may proceed in either direction according to the conditions under which it occurs—



The direction of the change may be most readily influenced by removing the substances on one side or the other of the equation by some means, so that the reverse change cannot take place. Thus, if a strong dehydrating agent like sulphuric acid be added to combine with the water, and the mixture be heated, the ethyl acetate distils over and the ester formation proceeds from left to right of the equation. On the other hand, if potassium hydroxide be added, this combines with the acetic acid to form potassium acetate, which does not react with the alcohol, and the reaction proceeds from right to left, *i.e.*, the ester is completely saponified. The “limiting value” in any given case is not affected by temperature, although the velocity of reaction is increased by raising the temperature; that is, the higher the temperature the sooner is the “limiting value” of the reaction attained. In the process given in the Pharmacopœia,

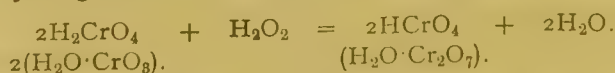


dried sodium acetate is used so as to avoid introducing water of crystallisation into the reaction mixture, while the sulphuric acid liberates acetic acid from the acetate, and withdraws the water produced in the formation of the ethyl acetate. [*Dose*.—20 to 40 minims (repeated); 60 to 90 minims (single).

## Æther Purificatus.

**Purified Ether** is prepared from ordinary ether by first shaking it with water to remove alcohol, which passes into the aqueous layer. The upper ethereal layer containing about 3 per cent. of dissolved water is then shaken with dehydrating agents such as calcium chloride or quicklime, and after standing some time the liquid is redistilled.

**Tests.**—Purified ether should be of specific gravity 0·720 to 0·722. Five cubic centimetres, allowed to evaporate spontaneously, should not afford any abnormal odour at any stage of the evaporation and should leave no residue. Its vapour is heavy (about two-and-a-half times heavier than air) and inflammable. Freedom from more than traces of water is shown by adding it to an equal volume of carbon disulphide with which anhydrous ether forms a clear liquid; if any water be present, it is precipitated in minute drops rendering the liquid turbid. Purified ether should not begin to boil below 34·5° C., which is very nearly the boiling point of pure ethyl oxide (35° C.). This excludes the presence of methyl oxide and other products derived from methylated spirit (*vide* notes on “Æther”). Shaken with solid potassium hydroxide, purified ether shows no change of colour, indicating freedom from aldehyde. Traces of aldehyde are produced in manufacture, but should be removed by the subsequent purification. Its detection in ether depends upon the production by action of caustic alkali of the yellow substance known as aldehyde-resin, which is so called from its physical resemblance to resin. It is a substance of unknown constitution, but probably a polymerisation product of ordinary aldehyde. Absence of acid is shown by immersing blue litmus paper in the ether; no alteration of colour should be produced, even on prolonged soaking. When carelessly stored and exposed to light and air, ether undergoes oxidation, with production of several substances, prominent among which is hydrogen peroxide. This may be detected by shaking the ether with half its bulk of a dilute solution of potassium bichromate acidulated with sulphuric acid; the ethereal layer which separates should have no blue colour. The test depends upon the formation of perchromic acid, which dissolves in the ether, imparting to it a blue tint. This perchromic acid is a very unstable compound, and its composition has not yet been accurately determined. It is probably represented by the formula  $\text{HCrO}_4$ , and may be regarded as derived from perchromic anhydride,  $\text{Cr}_2\text{O}_7$ . Its production is due to the oxidation of chromic acid by means of the hydrogen peroxide, which is thereby reduced to water—



It is necessary to use, as directed in the Pharmacopœia, a dilute solution of potassium bichromate, because perchromic acid is destroyed by excess of

chromic acid. The absence of most impurities, other than those already mentioned, may be determined by pouring some of the ether on to a piece of filter paper lying on a plate: after the evaporation of the ether the filter paper should be odourless.

**Notes.**—Ether used in the form of spray for producing local anæsthesia, by freezing the skin and subjacent tissues, must be free from alcohol and water. If those be present, a moist film is left upon the skin and the anæsthetic effect is not so good, owing to the less rapid and complete evaporation of the fluid. Anhydrous ether prepared from methylated spirit and having a specific gravity of 0·715 to 0·717 is often used for this purpose, and acts well, owing to the low boiling point of the methyl oxide which it contains.

## Alcohol Absolutum.

**Absolute Alcohol** consists of ethyl hydroxide containing not more than 1 per cent. by weight of water. It is obtained by removing the water from the strongest rectified spirit by addition of dehydrating agents, such as dried calcium chloride and quicklime, and redistilling the liquid. By fractional distillation alone it is impossible to remove about the last 5 per cent. of water from rectified spirit. It is not usual to carry the process of simple rectification beyond the production of a distillate containing much more than 90 per cent. of alcohol, the remaining water being more easily removed by the addition of dehydrating agents after this strength has been reached.

**Characters and Tests.**—Absolute alcohol should have a specific gravity from 0·794 (equivalent to 99·95 per cent. of ethyl hydroxide by volume and by weight) to 0·7969 (equivalent to 99·4 per cent. of ethyl hydroxide by volume or 99 per cent. by weight). It is very volatile, the boiling point of pure ethyl hydroxide being 78° C., and hygroscopic; hence exposure to air or storage in imperfectly closed vessels leads to absorption of moisture. The presence of water in absolute alcohol beyond the official limits will be indicated by its higher specific gravity and may be also detected by shaking the alcohol with a small quantity (1 to 2 per cent.) of anhydrous copper sulphate. This nearly colourless salt will assume a decidedly blue colour if more than 1 per cent. of water be present, owing to the production of some blue crystals of ordinary copper sulphate  $\text{CuSO}_4, 5\text{H}_2\text{O}$ . Absolute alcohol should be free from the impurities mentioned under "Spiritus Rectificatus" and in other general characters should resemble it.

## Aloe Barbadensis.

**Barbados or Curaçao Aloes** is obtained by evaporating to dryness the juice which flows from the transversely cut leaves of various species of *Aloe* (N.O. Liliaceæ), including *Aloe vera*, Linné, and *A. chinensis*, Baker. The fleshy leaves of those plants contain a yellow juice in the cells of the pericycle, which escapes when the leaves are cut transversely. The juice is concentrated by



boiling, and when evaporation of moisture is nearly complete the residue is poured into boxes or gourds and allowed to solidify. This variety of aloes is produced in the Dutch islands of Aruba, Bonaire, and Curaçao, chiefly from *A. chinensis*. Very little, if any, is now produced in Barbados.

**Characters and Tests.**—Barbados or Curaçao aloes occurs in hard masses varying in colour from yellowish or reddish-brown to chocolate-brown or almost black. The fracture may be dull and waxy, or smooth and transparent, the differences in appearance being due to variations in the method of evaporating the juice. Small splinters of the opaque variety, when examined under the microscope, exhibit numerous minute crystals of aloin (barbaloin), imbedded in a transparent mass, but similar splinters from the glassy variety are quite transparent. The odour of the drug is disagreeable, and its taste is nauseous and bitter. This variety of aloes imparts a crimson colour to nitric acid, and yields only a slight bluish-green colour when the vapour of nitric acid is blown over the powdered drug mixed with sulphuric acid. The first reaction serves as a distinction from Socotrine and Zanzibar aloes, which impart to nitric acid a reddish or yellowish-brown colour; the second distinguishes Barbados or Curaçao aloes from Natal aloes, which yields a bright blue colour under similar treatment. Barbados or Curaçao aloes is almost entirely soluble in 90 per cent. alcohol diluted with half its volume of water, and should yield at least 70 per cent. to cold water.

**Notes.**—The distinctive characters of Barbados or Curaçao aloes are the evanescent crimson colour imparted to nitric acid and the slight bluish-green colour produced with sulphuric acid and the vapour of nitric acid. The opaque (hepatic or livery) variety appears to owe its peculiar appearance to the fact that evaporation is allowed to take place more slowly than in the case of the glassy or vitreous aloes, and the conditions are therefore more favourable to the crystallisation of aloin. Rapid concentration of the juice to the extreme limit, succeeded by a quick cooling process, results in the formation of homogeneous transparent masses, which show no trace of crystals. Such masses, however, may become more or less opaque on keeping, owing to the slow crystallisation of the aloin. The only other variety commonly met with in the vitreous form is Cape aloes, which occurs in dark masses, often with a greenish tinge. It is easily distinguished by its marked sour odour, pale yellow powder, and the permanent green colour it imparts to nitric acid after standing a few minutes. The chief constituent of Barbados or Curaçao aloes is 30 per cent. or more of crystallisable aloin (barbaloin and isobarbaloin), but the drug also contains a small quantity of aloë-emodin, together with a resin which consists of cinnamic acid combined with barbaloresinotannol.

[Dose.—2 to 5 grains.]

## Aloe Socotrina.

**Socotrine and Zanzibar Aloes** are obtained by evaporating the juice that flows from the transversely cut leaves of *Aloe Perryi*, Baker (N. O. Liliaceæ) and other species of *Aloe*. As in the case of Barbados aloes,

the juice is contained in the cells of the pericycle and escapes when the leaves are cut. It is collected in the island of Socotra and on the east coast of Africa, whence it is exported to Europe by way of Bombay. The juice is allowed to evaporate spontaneously, and arrives in this country in a semi-liquid or pasty condition; if the kegs or tins containing Socotrine aloes are allowed to remain undisturbed for awhile, the brownish-yellow, viscid, opaque contents tend to separate into a clear, dark-brown liquid and a dark yellow deposit of aloin in crystals. The odour of the fresh aloes is unpleasant, but an agreeable fragrance is developed on keeping. Zanzibar aloes may be regarded as a variety of Socotrine aloes.

**Characters and Tests.**—Socotrine aloes, as imported, is usually more or less viscid and of a brownish-yellow colour, but when dried at a gentle heat it forms hard dark-brown or nearly black masses, which break with a dull, waxy, uneven fracture, and are characterised by a strong but not disagreeable odour and an extremely bitter, nauseous taste. Zanzibar aloes is usually imported in liver-brown masses, which break with a dull, waxy fracture, differing from that of Socotrine aloes in being nearly smooth and even. The odour of Zanzibar aloes is strong and characteristic, and its taste is nauseous and bitter. Both Socotrine and Zanzibar aloes are usually of the opaque, hepatic variety, though they also occur in the vitreous variety. Examined under the microscope they exhibit numerous minute crystals of aloin (socaloin) imbedded in a transparent mass. Both kinds impart to nitric acid a reddish or yellowish-brown colour (distinction from Barbados and Curaçao aloes), and when the vapour of nitric acid is blown over the powder mixed with sulphuric acid no blue coloration is produced (distinction from Natal aloes). Both Socotrine and Zanzibar aloes dissolve almost entirely in 60 per cent. alcohol or in 90 per cent. alcohol diluted with half its volume of water, and they should yield about 50 per cent. to water, leaving a practically inert residue. The solubility test suffices to exclude inferior samples of the drug.

**Notes.**—The distinctive characters of Socotrine and Zanzibar aloes are the reddish or yellowish-brown colour imparted to nitric acid and the absence of colour when the powder is treated with sulphuric acid and the vapour of nitric acid. The nitric acid test is very important, as no true Socotrine or Zanzibar aloes imparts a crimson colour to the reagent. Garnet-coloured, translucent Socotrine aloes from *A. Perryi* may be seen in museums, but is not now found in commerce. Samples which are nearly black are unfit for pharmaceutical purposes. Fine qualities of Zanzibar aloes are sometimes slightly translucent. The chief constituent of Socotrine and Zanzibar aloes is barbaloin (socaloin or zanaloin); other constituents are aloë-emodin, and a similar resinous body to that found in Barbados aloes, probably consisting of paracumaric acid combined with capaloresinotannol. [Dose.—2 to 5 grains.]

## Aloinum.

**Aloin** is the generic term applied to the crystalline, purgative, glucosidal principles found in all varieties of aloes, but only that obtained from Barbados, Curaçao, Socotrine, or Zanzibar aloes is official. The aloins are anthracene derivatives, varying in composition according to their source, and to them are



due the colour reactions of aloes. Barbados and Curaçao aloes yield barbaloin,  $C_{16}H_{16}O_7, 3H_2O$ , Socotrine and Zanzibar aloes yield socaloin or zanaloin, which seems to have the same composition. Aloin is extracted by making the aloes into a thin paste with alcohol, and allowing it to crystallise out, after which it is purified by recrystallisation from alcohol and, subsequently, from water.

**Characters.**—Aloin usually occurs in tufts of needle-shaped yellow crystals, which are inodorous, but possess the characteristic taste of aloes. They are sparingly soluble in cold water (1 in 400), more soluble in 90 per cent. alcohol (1 in 18), freely soluble in hot water or alcohol, but nearly insoluble in ether. Aloin is not readily altered in acid or neutral solutions, but it is rapidly altered in alkaline liquids.

**Notes.**—When crystallised from absolute alcohol, aloin is anhydrous and, if obtained from any of the official aloes, has the formula  $C_{16}H_{16}O_7$ , but on recrystallisation from water it takes up three molecules of that liquid. The amount of aloin contained in aloes varies considerably, and is believed to increase with age. Curaçao aloes is chiefly, if not exclusively, used by manufacturers as the source of aloin, and yields about 30 per cent. of the crystalline product. Though the aloins obtained from the different official varieties of aloes appear to be identical in composition, and agree in yielding chrysammic, aloetic, picric, and oxalic acids when treated with nitric acid, the aloin obtained from Socotrine and Zanzibar aloes is stated to give a distinct colour reaction with that acid. Thus, aloin from Barbados and Curaçao aloes—known as barbaloin or  $\alpha$ -barbaloin—is said to be distinguished by the red colour it gives with cold nitric acid (specific gravity, 1.42), the aloin from Socotrine and Zanzibar aloes—known as socaloin, zanaloin, or  $\beta$ -barbaloin—being understood to give no red coloration with the cold acid, though it gives an orange-red coloration when heated with the reagent, whilst also giving a red coloration in the cold with fuming nitric acid. Socaloin ( $\beta$ -barbaloin) is a rarity, the commercial aloin being  $\alpha$ -barbaloin from Barbados or Curaçao aloes. Nataloin, from Natal aloes, yields picric and oxalic acids when oxidised, but not chrysammic acid, and it is not reddened by nitric acid, even when heated with that reagent.

## Alumen.

**Alum** is a crystallised double sulphate of aluminium and potassium,  $Al_2(SO_4)_3, K_2SO_4, 24H_2O$ , or of aluminium and ammonium  $Al_2(SO_4)_3, (NH_4)_2SO_4, 24H_2O$ . It is obtained from aluminous shale containing iron sulphide, which, by roasting and lixiviation with water, yields crude aluminium sulphate. To the solution of aluminium sulphate, potassium or ammonium sulphate is added, and the crystals of alum which form are purified by recrystallisation.

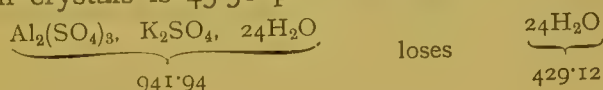
**Characters and Tests.**—Alum forms colourless, transparent, glassy, octahedral crystals, having a sweetish astringent taste. It is soluble in ten parts of cold and one-third part of boiling water, the solution having an acid reaction; it is also freely soluble in glycerin, but insoluble in strong alcohol. It affords the

reactions characteristic of aluminium, potassium (or ammonium) and sulphates. It should give a clear solution with water, and yield no definite reaction with the tests for arsenium, copper, lead, zinc, calcium, and sodium, or for more than traces of iron.

**Notes.**—The term “alum,” in its widest sense, includes a whole group of isomorphous crystalline salts, to which the general formula  $M_2(SO_4)_3 \cdot M^1_3SO_4 \cdot 24H_2O$ , may be given. The letter M in this formula may stand for Al, Cr, or Fe(ic), and the letter M<sup>1</sup> for one of the alkali metals K, Na, Cs, Rb, as well as Ag and the ammonium group NH<sub>4</sub>. The substance commonly known as chrome alum is  $Cr_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O$  (chromium-potassium alum), while iron alum is  $Fe_2(SO_4)_3 \cdot K_2SO_4 \cdot 24H_2O$  (iron-potassium alum). In this sense, therefore, an “alum” does not necessarily contain any aluminium at all, the term “alum” being used to indicate a whole class of salts, as defined above, which are isomorphous—*i.e.*, which crystallise in the same form, and contain the given proportion of water of crystallisation. The common alum used in medicine is, however, always understood to be aluminium-potassium or aluminium-ammonium alum. [*Dose.*—5 to 10 grains.]

## Alumen Exsiccatum.

**Exsiccated Alum** is obtained by heating aluminium-potassium alum until it has lost between 45 and 46 per cent. of its weight. The alum first melts in the water of crystallisation, which is expelled almost entirely by the continued application of heat, the residue consisting of nearly anhydrous aluminium and potassium sulphates. The proportion of water contained in potassium-alum crystals is 45.56 per cent. for



**Characters.**—Exsiccated alum is a white powder, slowly but completely soluble in twenty times its weight of cold water, and in three-fourths its weight of boiling water. It absorbs moisture on exposure to air.

**Notes.**—If the alum be overheated in drying (above 200° C.), some sulphuric acid is expelled, and the residue will contain a corresponding quantity of aluminium oxysulphate. Under those circumstances, the product will not completely dissolve in water. Exsiccated alum forms a very powerful dessicative dusting powder, because it not only combines with its own weight of water to re-form alum, but the product also exerts its characteristic astringent properties. It is commonly known as “burnt” or “dried” alum.

## Ammoniacum.

**Ammoniacum** is a gum-resin which exudes from the flowering and fruiting stem of *Dorema Ammoniacum*, D. Don (N.O. Umbelliferae), and probably other species, the plants that yield it being widely distributed throughout Persia and extending into Southern Siberia, though the drug is chiefly collected in Central Persia. The stem of *D. Ammoniacum*, and especially the bark, abounds in a milky secretion, contained in large schizogenous ducts. During the fruiting season large numbers of boring beetles are attracted to the plant and puncture the stem, thus causing the secretion to exude in the form of milky drops, some



of which harden into tear-shaped masses on the stem, while others fall to the ground and there become mixed with stones, dirt, stalks of the plant, mericarps of the fruit, and other impurities, the masses so formed being known in commerce as lump ammoniacum. Towards the end of July the drug is collected by peasants, being afterwards shipped in a crude state from ports in the Gulf of Persia to Bombay, where it is sorted before being exported to Europe.

**Characters and Tests.**—Ammoniacum should occur in small, dull, pale-yellowish or brownish tears, or in nodular or irregular rounded masses, varying from 6 to 26 Mm. in diameter. It is hard and brittle when cold, but softens when warmed, and the colour darkens to brown on keeping. Internally the tears, or masses, are opaque, and the colour varies from milky white to pale brownish-yellow, a freshly fractured surface having an opaque waxy appearance and being coloured yellow by solution of potassium hydroxide, or dark red or orange by solution of chlorinated soda. The drug possesses a faint, non-alliaceous, but characteristic, odour, and a bitter acrid taste. When crushed and triturated with water it forms a white emulsion, which is coloured yellow by solution of potassium hydroxide and deep orange-red by solution of chlorinated lime (distinction from African ammoniacum), while a transient violet colour, due to the presence of free salicylic acid, is produced on adding solution of ferric chloride. The gum-resin does not contain umbelliferone, as proved by strongly heating a small fragment in a dry test-tube and, after cooling, treating the contents of the tube with boiling water; on largely diluting the solution thus obtained, with cold water, and making it alkaline with solution of ammonia, no blue fluorescence is exhibited as in the case of African ammoniacum, asafetida, or galbanum. Ash yield, about 7 per cent.

**Notes.**—The distinctive characters of ammoniacum are its occurrence in clean, hard pieces which do not crumble between the fingers, the characteristic odour, presence of salicylic acid, and absence of umbelliferone. African ammoniacum, from *Ferula communis*, Linné, var. *brevifolia*, contains umbelliferone and does not yield an orange-red colour with solution of chlorinated lime. True ammoniacum is only sparingly soluble in water, but dissolves to the extent of 80 per cent. when digested with several times its volume of 90 per cent. alcohol, and yields 60 per cent. of its weight to 60 per cent. alcohol. Ammoniacum of good quality contains from 1 to 2 per cent., or more, of volatile oil, 65 to 70 per cent. of resin, about 20 per cent. of gum, 2 to 12 per cent. of moisture, and 3.5 per cent. of insoluble residue. The resin is a mixture of two resin-alcohols—galba-resinotannol (also found in galbanum), which is combined with salicylic acid, and ammo-resinotannol, which is peculiar to ammoniacum. The gum is an acid calcium arabinatate, allied to gum acacia.

[Dose.—5 to 15 grains.

## Ammonii Benzoas.

**Ammonium Benzoate**,  $C_6H_5COONH_4$ , is obtained by neutralising benzoic acid with solution of ammonia.

**Characters and Tests.**—Ammonium benzoate forms colourless lamellar crystals, soluble in 6 parts of cold water, 30 of alcohol (90 per cent.), and in 8

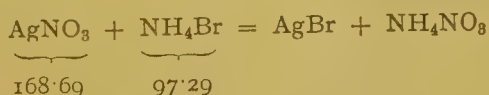
**Notes.**—The precipitation of flesh-coloured ferric benzoate with ferric chloride is the only qualitative reaction which can be utilised for the detection of benzoates. Cinnamates are distinguished by giving a yellow precipitate, and salicylates a violet coloration. [Dose.—5 to 15 grains.]

[Dose.—5 to 15 grains.

Ammonii Bromidum.

**Ammonium Bromide**,  $\text{NH}_4\text{Br}$ , may be prepared by neutralising hydrobromic acid with ammonia, or by the action of bromine on solution of ammonia, or by the action of ammonia and ammonium carbonate on solution of ferrous bromide.

**Characters and Tests.**—Ammonium bromide forms small colourless crystals. Taste saline and somewhat pungent. When heated it sublimes unchanged, and without residue. Soluble in water (2 in 3) and in alcohol (1 in 15). Its reactions are those of ammonium and of bromides; 0.5 gramme of the dry salt dissolved in water should require for complete precipitation not more than 51.8 and not less than 51.1 C.c. of decinormal solution of silver nitrate.



9.729 grammes $\text{NH}_4\text{Br}$	require	1000	C.c. N/10 $\text{AgNO}_3$ solution
∴ 1 " "	"	$\frac{1000}{9.729}$	" " " "
∴ 0.5 " "	"	$\frac{1000 \times 0.5}{9.729}$	" " " "
		= 51.4 C.c.	

Ammonium bromide should be almost free from lead, iron, bromates, iodides, and nitrates, and should contain only slight traces of sulphates and chlorides.

**Notes.**—If ammonium bromide be perfectly pure, 51·4 C.c. of decinormal silver nitrate solution will be required in the official test, as shown. Traces of iodides and chlorides are, however, usually present in the official salt; hence the variation allowed, because iodides require less and chlorides more silver nitrate than the same weight of bromide. If chlorides and iodides be present at the same time, they may neutralise each other in their effects upon the titration test, but the presence of more than traces of such impurities will be revealed in the qualitative examination of the salt. [*Dose.*—5 to 30 grains.]



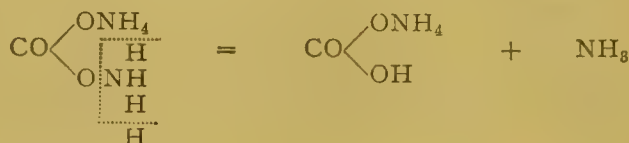
## Ammonii Carbonas.

**Ammonium Carbonate** is prepared by submitting to sublimation a mixture of calcium carbonate (chalk) and ammonium sulphate or chloride. The primary reaction which occurs is the formation of normal ammonium carbonate.

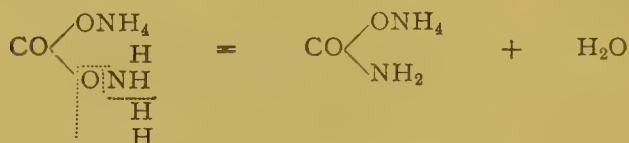


The sublimate, however, consists, not of normal carbonate, but of about equimolecular proportions of acid carbonate and carbamate formed by loss of ammonia and water, respectively, from the normal carbonate.

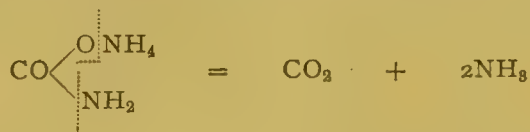
(i.)



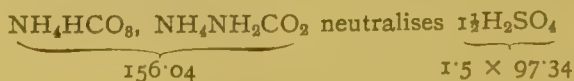
(ii.)



**Characters and Tests.**—Ammonium carbonate forms translucent crystalline masses with an ammoniacal odour and alkaline reaction; slowly, but completely, soluble in about 4 parts of cold water. Exposed to the air it becomes covered with a white pulverulent efflorescence and finally leaves a white powdery residue, consisting of ammonium hydrogen carbonate only. This residue no longer smells strongly of ammonia and requires about 8 parts of water for complete solution. Its production is due to the disappearance of the ammonium carbamate which volatilises as carbon dioxide and ammonia.



For dispensing purposes the efflorescences should always be removed by scraping and the translucent interior portion alone employed because the acid carbonate contains relatively less real ammonia. Thus the salt of the formula  $\text{NH}_4\text{HCO}_3$  (molecular weight 78.49) contains one molecule of  $\text{NH}_3$  (molecular weight 16.94) which is equivalent to 21.58 per cent., while the carbamate  $\text{NH}_4\text{NH}_2\text{CO}_2$  (molecular weight 77.55) contains 43.69 per cent. and the official carbonate, composed of equimolecular proportions of acid carbonate and carbamate ( $\text{NH}_4\text{HCO}_3, \text{NH}_4\text{NH}_2\text{CO}_2 = \text{N}_3\text{H}_{11}\text{C}_2\text{O}_5$ , molecular weight 156.04) 32.57 per cent. of  $\text{NH}_3$ . The official salt affords the reactions characteristic of ammonium salts and carbonates. One gramme dissolved in about 40 C.c. of water should neutralise not less than 18.7 C.c. of normal sulphuric acid solution.



Since the normal solution of sulphuric acid contains 48.67 grammes of sulphuric acid ( $\text{H}_2\text{SO}_4/2$ ), 156.04 grammes of ammonium carbonate—consisting of equi-

molecular proportions of carbamate and acid carbonate — will neutralise 3,000 C.c. of normal sulphuric acid—

$$\therefore 1 \text{ gramme should neutralise } \frac{3,000}{156.04} \text{ C.c.} = 19.2 \text{ C.c.}$$

The official requirement, 18.7 C.c., allows therefore for the salt to be rather weaker in ammonia than is indicated by the above formula. Even with this allowance the commercial salt is said never to reach the official standard. Ammonium carbonate leaves no residue when strongly heated and should only contain the slightest traces of chlorides and sulphates. The commercial source of ammonium salts is the ammoniacal liquors of the gas works. Since coal tar is also one of the by-products, the salts of ammonium are liable to be contaminated with traces of tarry products. The tarry odour is usually masked by the pungent odour of the ammonia; if, however, the carbonate be dissolved in water and then neutralised by an acid (*e.g.*, sulphuric acid), the solution of the salt so produced should be free from empyreumatic odour. After evaporating this solution to dryness, the residue should be colourless and odourless.

**Notes.**—Carbamic acid, whose ammonium salt forms one of the constituents of the official Ammonii Carbonas, is a very interesting body on account of its relationship to carbonic acid and urea. Carbonic acid, which is believed to have the formula  $\text{CO} \begin{smallmatrix} \text{OH} \\ \text{OH} \end{smallmatrix}$ , forms two amides— $\text{CO} \begin{smallmatrix} \text{NH}_2 \\ \text{OH} \end{smallmatrix}$  and  $\text{CO} \begin{smallmatrix} \text{NH}_2 \\ \text{NH}_2 \end{smallmatrix}$ —by

replacement of one or both its hydroxyl groups with the amido group  $\text{NH}_2$  (compare amines and amides in a text book of organic chemistry). The first is carbamic acid, its acid properties depending upon the presence of the hydroxyl group (OH) associated with the negative carbonyl group (CO). If the hydrogen of the remaining hydroxyl group be replaced by  $\text{NH}_4$  ammonium carbamate,

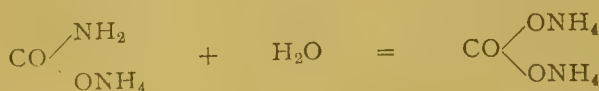
$\text{CO} \begin{smallmatrix} \text{NH}_2 \\ \text{ONH}_4 \end{smallmatrix}$ , results. The second amide, carbamide, is the well-known body

urea. This is not an acid, since the second hydroxyl group of the carbonic acid is now replaced by the basic radical  $\text{NH}_2$ . When Ammonii Carbonas is dissolved in water and solution of ammonia added, the solution probably contains normal ammonium carbonate, the acid carbonate and carbamate taking up ammonia and water respectively; thus—

(i.)



(ii.)



[Dose.—3 to 10 grains.]

## Ammonii Chloridum.

**Ammonium Chloride** is obtained by neutralising the crude ammonia of the gas works with hydrochloric acid and purifying the product by crystallisation or sublimation.

**Characters and Tests.**—Ammonium chloride forms colourless, odourless crystals, soluble in 3 parts of cold water and in 60 parts of alcohol (90 per



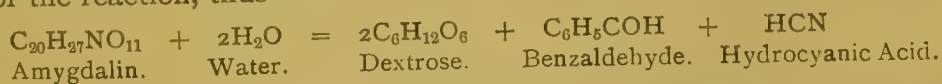


**Notes.**—The gravimetric test of purity described in the Pharmacopœia is the routine method for the determination of phosphates in neutral or alkaline solution. Conversely the method serves for the determination of magnesium. The proper conditions for the successful performance of this determination are not fully described in the Pharmacopœia. They will, however, be found in text-books dealing with quantitative analysis, and should be properly understood before the process is attempted. Phosphates which are only soluble in acid must first be separated by the use of ammonium molybdate; the molybdic precipitate, redissolved in ammonia, may then be treated with the magnesium ammonio-sulphate. [Dose.—5 to 20 grains.]

## Amygdala Amara.

**Bitter Almonds** are the ripe seeds of *Prunus Amygdalus*, Stokes, var. *amara*, Baillon (N.O. Rosaceæ), a native of Persia, Asia Minor, and Syria, naturalised in the Mediterranean basin and Central Europe, and maturing its fruit in some parts of England. The fruit of the almond tree is a green velvety drupe, from which the fleshy mesocarp and thin epicarp separate as ripening proceeds, leaving the seed enclosed in the shell-like endocarp. There are several varieties of the bitter almond, the best being imported from the South of France, and others from Sicily and Northern Africa (Barbary).

**Characters.**—Bitter almonds agree in general appearance with sweet almonds, resembling more particularly the Valencia variety, but, generally speaking, they are shorter, proportionately broader, and usually smaller and less regular. They are exalbuminous, free from starch, contain two large plano-convex oily cotyledons, and are covered with a thin, rough, cinnamon-brown testa or seed-coat. The bitter taste of the seeds is characteristic, as is also the odour of hydrocyanic acid and benzaldehyde given off by the white emulsion formed when the seeds are triturated with water. The seeds contain amygdalin,  $C_{20}H_{27}NO_{11}$ , to which their bitter taste is due. It is a colourless crystalline glucoside, soluble in alcohol and water, and is decomposed in the presence of water by emulsin (synaptase), an enzyme found in sweet and bitter almonds. Dextrose, benzaldehyde (essential oil), and hydrocyanic acid are the products of the reaction, thus—



As the amygdalin is localised in the parenchyma of the cotyledons, while the enzyme resides in the axile parts of the embryo and the vascular bundles of the cotyledons, the two substances are unable to come in contact until the seeds are crushed and water is added.

**Notes.**—The distinctive characters of bitter almonds are their small size, broadly ovoid shape, bitter taste, and the characteristic odour of the emulsion formed on triturating them with cold water. They contain various proteids and about 38 per cent. of a bland fixed oil, which can be separated by heavy pressure. They also yield from 0·5 to 0·8 per cent. of volatile oil, and 0·25 per cent. of



hydrocyanic acid, both of which can be extracted from the cake left after expression of the fixed oil. Water is added to the cake, and the mixture left for some hours, after which it is distilled. The hydrocyanic acid in the distillate is partly free and partly combined as benzaldehyde-cyanhydrin. It can be separated by shaking the oil with milk of lime, with which the acid combines to form calcium cyanide; the addition of ferrous sulphate converts that compound into Prussian blue, and, on redistillation in a current of steam, the volatile oil (benzaldehyde) is obtained pure.

## Amygdala Dulcis.

**Sweet Almonds** are the ripe seeds of *Prunus Amygdalus*, Stokes, var. *dulcis*, Baillon (N.O. Rosaceæ), which is not distinguished from the bitter almond tree by any permanent character, but grows in the same districts, and is cultivated more largely. The seeds known in commerce as Jordan almonds are alone official. Other varieties of seeds, distinguished in the order of their value, are the Valencia, Sicily, and Barbary almonds. Jordan almonds are imported from Malaga, free from the endocarps, and are distinguished from all others by their large size, and long, narrow shape.

**Characters.**—Sweet almonds resemble the bitter ones in general appearance, the Valencia variety resembling them closely; but Jordan almonds, which alone are official, are 2.5 Cm. or more in length, nearly oblong in outline, more or less compressed, pointed at one extremity and rounded at the other. The thin, rough testa or seed-coat is cinnamon-brown, the seed is exalbuminous and free from starch, and it contains two large plano-convex oily cotyledons. The seeds have a bland taste, and the white emulsion formed when they are triturated with water is distinguished by no marked odour.

**Notes.**—The distinctive characters of Jordan almonds are their elongated shape, bland taste, and the freedom from marked odour of the emulsion formed on triturating the seeds with cold water. Like bitter almonds, they contain various proteids (about 20 per cent.), including the enzyme, emulsin, together with about 45 per cent. of the same fixed oil that is found in bitter almonds, but they do not contain amygdalin, and, consequently, yield no volatile oil (benzaldehyde) or hydrocyanic acid when crushed and triturated with water. Almonds are readily freed from their coats or skins (blanched) by steeping in cold water; they must be thoroughly dried subsequently if they are to be used for preparing compound powder of almonds, as they can then be rubbed to a smoother consistence and the resulting powder keeps better.

## Amyl Nitris.

**Amyl Nitrite** is a liquid obtained by the action of nitrous acid upon amylic alcohol which has been distilled between 127.7° and 132.2° C. Commercial amylic alcohol is obtained from the crude fusel oil which is a by-

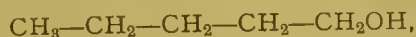
product in the manufacture of ordinary alcohol. This fusel oil is composed chiefly of a mixture of propyl, butyl, and amyl alcohols. Since the boiling points of these homologous alcohols rises with the increase in their molecular weights the crude fusel oil is fractionally distilled and the portion coming over between the temperatures mentioned above is known commercially as amylic alcohol. It consists chiefly of iso-butyl-carbinol (sometimes known as iso-amyl or fermentation amylic alcohol), one of the eight possible isomeric amyl alcohols—



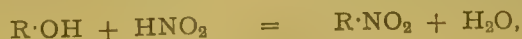
Another constituent is the alcohol known as “active” amyl alcohol—



which is so called from its effect in rotating a ray of polarised light, this being due to the presence of the asymmetric carbon atom (marked with an asterisk in the formula). Only small quantities of normal amyl alcohol—



are found in the commercial amylic alcohol. It contains in addition a little propyl and butyl alcohols which are not entirely separable by fractional distillation. When the amylic alcohol is treated with nitrous acid all of its constituent alcohols are acted upon so that the resulting product is a mixture of nitrites corresponding to the alcohols actually present, but in which iso-amyl nitrite should largely predominate. This is secured by employing that fraction of the rectified amylic alcohol which comes over within a few degrees of the boiling point of iso-amyl alcohol (131° C.). The manufacture of the nitrite may be carried out in two ways:—(1) By saturating the alcohol with nitrous fumes, obtained by heating nitric acid with arsenious anhydride or starch. After standing some time the product is shaken with water and sodium bicarbonate to neutralise free acid. The oily layer which arises is then dried with calcium chloride and redistilled. (2) The amyl alcohol may be mixed with sulphuric acid and a strong solution of sodium nitrite added. The ethereal layer which separates is then washed and rectified as in the other process. In both cases the reaction may be simply regarded as between nitrous acid and the alcohol—



and therefore comparable to the reaction between a metallic hydroxide and an acid.

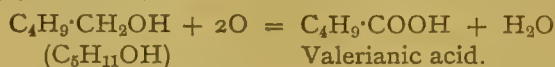
**Characters and Tests.**—Amyl nitrite is an ethereal liquid of a yellowish colour, fragrant odour, and not more than the faintest acid reaction. It deteriorates when exposed to air, light, and moisture, the nitrite being hydrolysed to alcohol and nitrous acid. Almost insoluble in water; soluble in all proportions in 90 per cent. alcohol. When amyl nitrite is added drop by drop to fused potassium hydroxide, potassium valerianate is formed. In this reaction the amyl nitrite is first saponified into amyl alcohol and potassium nitrite. The alcohol is then immediately oxidised by the nitrite to the corre-



sponding valerianic acid, which unites with some potassium hydroxide to form the valerianate.



The acid is derived from amyl alcohol by the oxidation of the carbinol group,  $\text{CH}_2\text{OH}$ , to carboxyl,  $\text{COOH}$ , thus



When submitted to fractional distillation, about 70 per cent. should pass over between  $90^\circ$  and  $100^\circ$  C., showing that a due proportion of iso-amyl nitrite is present, the boiling point of that body being about  $95^\circ$  C. The more exact valuation of its nitrite content may be effected by the nitrometer, as described under Spiritus Ætheris Nitrosi. As amyl nitrite evolves a relatively large volume of nitric oxide it is better to work on a diluted product obtained by dissolving one volume of the substance in sufficient 90 per cent. alcohol to produce twenty volumes; 5 C.c. of this mixture will therefore contain 0.25 C.c. of amyl nitrite, and should yield at least 30 C.c. of nitric oxide when treated with solution of potassium iodide and diluted sulphuric acid. The preliminary dilution facilitates the measurement of the nitrite, and the diluted product reacts more readily in the nitrometer, since undiluted amyl nitrite is only slightly soluble in aqueous liquids. When shaken with an equal volume of potassium hydroxide solution, the official amyl nitrite should communicate only a pale yellow colour to the aqueous layer, showing that only a small proportion of aldehyde is present. This test depends upon the production of a yellow substance known as aldehyde-resin. It is probably a polymer of aldehyde, formed by the action of the potassium hydroxide, and has a more complex constitution than paraldehyde or metaldehyde. When a small quantity of amyl nitrite is placed in a test tube immersed in melting ice, the liquid should remain clear and show no deposition of water globules. Amyl nitrite, at ordinary temperatures, takes up a small quantity of water, which is deposited at lower temperatures. Its presence would be due to insufficient rectification after manufacture and is objectionable, not so much on account of the slight dilution which is thereby effected, but because the water slowly hydrolyses the nitrite to amyl alcohol and nitrous acid, thus—



**Notes.**—The esters of nitrous acid have probably the constitution  $\text{R}-\text{O}-\text{N}=\text{O}$ , *i.e.*, the nitrogen, is connected with the organic radical (methyl, ethyl, amyl, etc.) through an oxygen atom, and not directly. In correspondence with this view nitrites are, like other esters, easily saponified to alcohol and nitrous acid.



When reduced by nascent hydrogen they also yield alcohol, while the nitrogen is separated from the radical, and appears as ammonia or hydroxylamine  $\text{NH}_2\cdot\text{OH}$ . The formula  $\text{C}_5\text{H}_{11}\text{NO}_2$  is also that of the isomeric nitro-pentane. The nitro-derivatives, on the other hand, appear to have the nitrogen directly

connected with the carbon of the radical,  $\text{R}-\text{N}\begin{smallmatrix} \diagup \text{O} \\ \diagdown \text{O} \end{smallmatrix}$  or  $\text{R}-\text{N}\begin{smallmatrix} \diagup \text{O} \\ | \\ \diagdown \text{O} \end{smallmatrix}$ , for when reduced by hydrogen they yield an amine in which the nitrogen remains attached to the radical, thus—



[Dose (by inhalation).—2 to 5 minims as vapour.]

## Amylum.

**Starch** for pharmaceutical purposes must be procured from the grains or fruits of common wheat, *Triticum sativum*, Lamarck; from maize or cornflour, *Zea Mays*, Linné; or from rice, *Oryza sativa*, Linné, all three plants belonging to the N.O. Gramineæ. The cells containing the starch must be ruptured by crushing the grains, and the gluten and other soluble and insoluble matters can then be separated from the starch by adding water to form a dough, from which the starch grains can be washed by kneading the mass in a stream of water, the gluten, etc., being left behind. The gluten may also be removed from the crushed grains by dissolving it in dilute sodium hydroxide solution, or by allowing a mixture of crushed grains and water to undergo putrefactive decomposition, the gluten being destroyed in the latter process and acetic, lactic and other acids formed. In any case the starch must subsequently be purified by washing repeatedly with cold water to remove any traces of cell débris, alkali, or acid.

**Characters and Tests.**—Starch should be white and inodorous, and occur either as a fine powder or in irregular angular or columnar masses, which are readily reduced to powder. It is quite insoluble in cold water, and leaves only a trace of ash when incinerated. Freedom from traces of acid or alkali, remaining as the result of imperfect washing during the process of purification, should be indicated by the colour of blue or red litmus paper remaining unaffected when immersed in cold water, with which the starch has been lightly rubbed in a mortar. As a rule, however, starch is faintly alkaline. On boiling with water the starch grains are ruptured, and a gelatinous mixture results; on cooling the mixture and adding solution of iodine, a deep blue addition compound of starch and iodine is formed. Wheat starch occurs in grains, which vary considerably in size, the larger usually measuring from  $30\mu$  to  $38\mu$  in diameter and the smaller from  $6\mu$  to  $7\mu$ , though both larger and smaller ones may be met with. The large granules show a central hilum surrounded by faint concentric striæ, and are either flattened or lens-shaped, appearing round or somewhat kidney-shaped when lying flat; when standing on edge they appear spindle-shaped. The hilum and striæ are less conspicuous in the smaller

granules; those are round or oval, and occasionally two or three may be found combined in a compound grain. Maize starch, the kind mostly used, consists of granules which are more uniform in size, measuring from  $10\mu$  to  $25\mu$  in diameter; they are round or polygonal with rounded angles, and have a very distinct hilum, usually with one or more small clefts radiating from it, but there are no striæ. Rice starch consists of still smaller granules, also very uniform in size, measuring from  $4\mu$  to  $6\mu$  in diameter; they are polygonal, with sharp angles, being in reality the fragments of large oval compound grains, and are usually without evident hilum, cleft, or striæ.

**Notes.**—Starch is a member of the cellulose group, its formula being a multiple of  $C_6H_{10}O_5$ . When air-dried it contains from 12 to 16 per cent. of moisture. It is present in all assimilating plants, being formed in the chlorophyll granules from the carbon dioxide absorbed. The granules are enveloped in an insoluble coating which probably consists of cellulose, and they contain granulose, the substance which forms a jelly when starch is heated with water. To examine the granules under the microscope they should be mounted in water; the addition of strong chloral hydrate or potassium hydroxide solution (near the edge of the cover glass) makes the hilum and striæ more plainly visible, but in either case the starch grains swell and gradually lose their distinctive shape, so that no time should be lost in completing the examination.

## Anethi Fructus.

**Dill Fruit** is the dried ripe fruit of *Peucedanum graveolens*, Bentham and Hooker filius (N.O. Umbelliferæ), an annual herb indigenous to the Mediterranean districts and Southern Russia, but cultivated in England and certain parts of the Continent of Europe. The fruit is an oblong or oval cremocarp, about 4 Mm. long, dorsally compressed, and usually separated into the two thin mericarps. The kinds met with in commerce are usually of British, German, or Indian origin. Preference should be given to the first two varieties, which alone meet the official requirements.

**Characters.**—Dill fruit is usually met with in the form of separate, smooth, brown, oval mericarps, freed from the pedicel, those points serving to distinguish British and German fruit from Indian dill fruit. Each mericarp is about 4 Mm. long and 2 to 3 Mm. broad, with five equidistant filiform ridges, and so strongly compressed dorsally as to be almost flat. In transverse section each mericarp exhibits six vittæ, or elongated oil-glands, four on the dorsal and two on the commissural surface. Three of the ridges are prominent—not inconspicuous, as officially stated—at the back, and the other two are merged in the broad, thin margin or wings. The agreeably aromatic odour and taste of the fruits are due to the volatile oil they contain. Ash-yield, about 7 per cent.

**Notes.**—The distinctive characters of dill fruit are the very flat, usually separate, mericarps, with three dorsal ridges and two winged lateral ridges. Indian dill, imported from Bombay, is more elliptical in form than British, more convex at the dorsal surface, and paler in colour; the mericarps of the fruits



are frequently united and attached to the pedicels; they are also narrower and less prominently winged than those of the British fruits. Dill fruit contains fixed oil, mucilage, and from 2 to 5 per cent. of volatile oil which consists almost entirely of limonene (carvene) and carvone (carvol), being almost identical in composition with oil of caraway.

## Anisi Fructus.

**Anise Fruit** is the dried ripe fruit of *Pimpinella Anisum*, Linné (N.O. Umbelliferae), an annual plant indigenous to Greece, Egypt, and Asia Minor, but cultivated largely in Southern Russia, Germany, Spain, Italy, South America, etc. The fruit is a cremocarp and is usually met with entire. The different commercial varieties—Russian, German (Thüringian), Greek, Maltese, Spanish (Alicante), Italian, and Chilian—differ from each other in size, colour, flavour, and relative freedom from impurity. When fresh, the Russian and German fruits are greyish-green in colour, the Levant and Spanish fruits, both of which are larger than other varieties, being brownish-green and yellowish-green respectively, but the greenish tints tend to become grey with age. Chilian fruits are so mixed with foreign matter that their colour is not readily discernible, and their mericarps are usually separated more or less. The larger varieties alone are admitted by the official description.

**Characters.**—Anise fruit consists usually of the entire cremocarp, the mericarps remaining united and attached to the pedicel. The cremocarp measures about 5 Mm. in length and 2 Mm. broad, is ovoid in form, greenish-brown or greyish-brown in colour, somewhat compressed laterally, and rough, owing to the presence of numerous short, cone-shaped, bristly hairs. Each mericarp is marked by five pale, slender, and entire ridges, two of which are lateral. In transverse section each mericarp of anise fruit exhibits from thirty to forty vittæ or oil tubes, the largest occurring in the commissure. The agreeably aromatic odour of the fruit and its aromatic sweet taste are due to the volatile oil contained in the vittæ. Ash-yield, about 6 per cent.

**Notes.**—The distinctive characters of anise fruits are the short, stout, bristly hairs, the entire fruits, the characteristic odour and taste, the absence of any deep groove in the endosperm and of prominent crenations on the somewhat inconspicuous primary ridges. In hemlock fruit, which has been found mixed with German and Italian anise, the ridges exhibit prominent crenations; there are no hairs or vittæ, and the endosperm exhibits a deep groove on its commissural surface. Hemlock fruit is also virtually devoid of odour or taste, though on crushing it and adding some potassium hydroxide solution, a strong mouse-like odour is developed. Anise fruits contain fixed oil, choline, sugar, mucilage, and about 1.5 to 3.5 per cent. of volatile oil which consists almost entirely of anethol.

## Anthemidis Flores.

**Chamomile Flowers** are the dried, expanded flower-heads of *Anthemis nobilis*, Linné (N.O. Compositæ), the common or Roman chamomile, collected

from plants cultivated in England, Belgium, France, Saxony, and Hungary. The flowers may occur in three forms—double, semi-double, and single or Scotch chamomiles, but the double and semi-double flowers alone are official. The English flowers yield most volatile oil when distilled and are usually reserved for distillation purposes; those imported from Belgium, France, and Saxony are chiefly met with in commerce. The entire flower-heads are collected for medicinal use and dried in a warm room.

**Characters.**—Chamomile flowers are from 12 to 20 Mm. in diameter, hemispherical in shape, and white or nearly white in colour when fresh, becoming buff-coloured or yellow when kept. Each flower-head is surrounded by an involucre consisting of two or three rows of overlapping oblong bracts with membranous margins, but that is almost entirely concealed when dried by the reflexed outer florets, which are ligulate, white, and pistillate. The inner florets of the semi-double variety are tubular, yellow, and hermaphrodite, but in double chamomiles the florets are all white and ligulate. On carefully removing the florets from a flower-head, the solid conical receptacle is seen to be covered with concave, blunt, narrow, scaly bracts or paleæ, one of which occurs at the base of each floret. The calyx limb is completely adherent to the ovary and indistinguishable owing to the absence of pappus, the calyx tube not being developed. The corolla is sprinkled with minute, yellowish, shining oil-glands on its lower part, as may be seen on closely examining it with a powerful lens. The strong aromatic odour of chamomiles is due to the volatile oil they contain, and their bitter taste to the presence of anthemic acid. Ash-yield, about 5 per cent.

**Notes.**—The distinctive characters of chamomiles are the solid elongated conical receptacle and the presence of the blunt, narrow, scaly bracts or paleæ. Single chamomiles, which are excluded by the official description, have only a single outer row of white ligulate florets, the rest being tubular and yellow. In German chamomiles, from *Matricaria Chamomilla*, Linné, the conical receptacle is hollow and there are no paleæ; in feverfew, *Chrysanthemum (Pyrethrum) Parthenium*, the receptacle is flat and any paleæ which may be present are acute. Chamomiles contain a bitter principle (anthemic acid), a crystalline physosterin (anthesterin), wax, fatty oil, glucose, and from 0.8 to 1 per cent. of a volatile oil which consists chiefly of various esters.

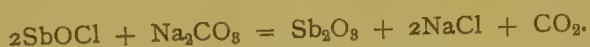
## Antimonii Oxidum.

**Antimonious Oxide** is so called in order to distinguish it from the higher oxide (antimonic oxide  $\text{Sb}_2\text{O}_5$ ). It is prepared by pouring a strong solution of antimonious chloride, containing some free hydrochloric acid, into a relatively large bulk of water. A precipitate of antimony oxychloride is formed by this dilution, the chloride reacting with water—



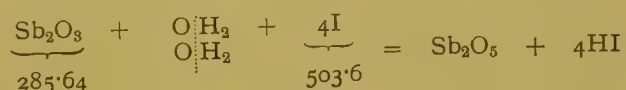
The precipitate is allowed to settle, the supernatant acid liquor poured off, sodium carbonate added and the mixture boiled. Effervescence occurs owing to the

liberation of carbon dioxide and the insoluble oxide is collected on a filter, washed and dried below 100° C. to avoid oxidation to antimonie oxide—



The production of antimony oxide by means of sodium carbonate is explained in the present instance by the fact that antimony carbonate, which we might expect to get by double decomposition, is unstable and splits up immediately into oxide and carbonic anhydride.

**Characters and Tests.**—Antimonious oxide is a greyish-white powder, melting when heated to low redness, insoluble in water, soluble in hydrochloric acid, forming a solution of antimonious chloride. This chloride is only stable in presence of excess of hydrochloric acid; if the concentration of this be diminished by neutralisation or dilution a precipitate of oxychloride is obtained. The purity of the substance is determined by titration with iodine solution; 0.5 gramme should be dissolved in a hot solution of 1 gramme potassium acid tartrate, with which the antimony oxide combines to form tartar emetic. In this compound the antimony is present in the antimonious state, and by titration with iodine in aqueous solution it is oxidised to the antimonie state—



One litre of decinormal solution of iodine (containing 12.59 grammes iodine = 503.6/40) is therefore capable of oxidising 7.14 (= 285.64/40) grammes of  $\text{Sb}_2\text{O}_3$

$$\therefore 1 \text{ C.c. N/10 Iodine solution} = 0.00714 \text{ gramme } \text{Sb}_2\text{O}_3$$

$$\therefore 70 \text{ C.c. N/10 Iodine solution} = (0.00714 \times 70) \text{ grammes} = 0.4998 \text{ gramme } \text{Sb}_2\text{O}_3$$

It will be seen that the action of the iodine on the antimonious compound results in the formation of hydriodic acid. This must be neutralised, otherwise, when a certain amount has been formed, a condition of equilibrium results, and the reaction will not go on to its completion, since hydriodic acid of a certain concentration behaves as a reducing agent towards antimonie compounds and the reaction proceeds no farther in the direction indicated by the equation. In order to neutralise the acid, sodium bicarbonate is added to the cooled liquid, for although normal carbonate and hydroxide of sodium will effect the same result, these last-mentioned salts themselves use up iodine and give a result in excess of the truth. Bicarbonate of sodium, on the other hand, has no effect upon the iodine. The full equation for the reaction between iodine and tartar emetic will be discussed under Antimonium Tartaratum, as well as the conditions for its satisfactory accomplishment. Antimonious oxide is said to dissolve completely when boiled with excess of potassium acid tartrate, but that is not correct except in the case of the freshly-precipitated compound; any insoluble residue indicates the probable presence of antimonie oxide.

**Notes.**—It will be observed that the formula given for antimonious oxide in the Pharmacopœia is  $\text{Sb}_4\text{O}_6$ —i.e., double that employed in the foregoing reactions. This selection of the actual number of atoms in the molecule is of course dependent upon the value found for the density of the vapour of the



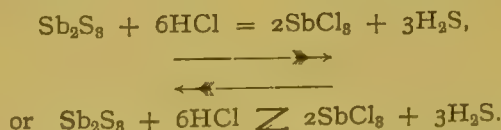
substance, and in the case of antimonious oxide corresponds to the formula  $\text{Sb}_4\text{O}_6$ . Half this formula—viz.,  $\text{Sb}_2\text{O}_3$ —has been employed in the equations for the sake of simplicity, and is the more justifiable, since the compound dealt with here is not the oxide in the state of vapour, but the solid oxide, whose molecular constitution is unknown, but probably corresponds to some higher multiple of  $\text{Sb}_4\text{O}_6$ . [Dose.—1 to 2 grains.]

## Antimonium Nigrum Purificatum.

**Antimonious Sulphide**, the native black sulphide of antimony, occurs in association with siliceous matter, and often contains also some sulphide of arsenic. It is purified by fusion from the siliceous matter, and if any arsenic be present this may be removed by digesting the finely-powdered material with solution of ammonia for several days. The ammoniacal liquor is then drained off and the residue washed and dried. This method of purification depends upon the extraction of the arsenic sulphide to form a soluble thio-arsenite of ammonium; the antimonious sulphide is only sparingly soluble in ammonia.

**Characters and Tests.**—Antimonious sulphide is a greyish-black, crystalline powder, reacting with hot strong hydrochloric acid, a solution of antimonious chloride being formed, while sulphuretted hydrogen is evolved. There should only be a slight insoluble residue if excess of acid be employed. Only traces of arsenic are allowable.

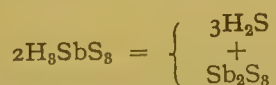
**Notes.**—In performing the test with hydrochloric acid the odour of the escaping gas will be found to be more intense than that associated with sulphuretted hydrogen prepared in the laboratory by the usual reaction between iron sulphide and sulphuric or hydrochloric acid. The cause of this is the presence in commercial iron sulphide of more or less metallic iron uncombined with sulphur, and this iron also reacts with the acid, producing a corresponding quantity of hydrogen which dilutes the  $\text{H}_2\text{S}$  simultaneously produced. On the other hand, black antimony sulphide is nearly pure, and hence the sulphuretted hydrogen produced from it suffers no dilution. The reaction may be written—



The two arrows pointing in reverse directions, and also the sign  $\rightleftharpoons$ , are used to indicate that the reaction proceeds in one direction or the other, dependent upon conditions not shown in the equation: in other words, the reaction is reversible. It will be readily recalled that antimony is precipitated in the course of qualitative analysis as sulphide by passing  $\text{H}_2\text{S}$  through its solutions. The chief condition which influences the course of the reaction is the concentration of the hydrochloric acid—in strongly acid solutions the reaction proceeds from left to right, in weakly acid solutions from right to left.

## Antimonium Sulphuratum.

**Sulphurated Antimony** is a complex mixture of antimonious and antimonious sulphides and oxides, containing at the same time some free sulphur, which can be extracted from the mixture by carbon bisulphide, in which the free sulphur is soluble. The actual proportions of the various constituents of the mixture depend upon the proportions of the materials used in making it as well as the conditions as to time, temperature, concentration, etc., under which the manufacture has been accomplished. It is stated that the product obtained by the official process does not comply with the official tests. Black sulphide of antimony and sublimed sulphur, 2 parts, are boiled with 1 part caustic soda in 20 parts of water for two hours, the water lost by evaporation being replaced during the process. Thirty parts of boiling water are then added, and the whole strained through calico. To the hot, strained liquid diluted sulphuric acid is added, until the reaction of the liquid is acid, and the precipitate which forms is collected, washed, and dried below  $100^{\circ}\text{C}$ . The production of this precipitate depends, in the first place, upon the capacity of antimony oxides and sulphides to unite with alkaline oxides and sulphides to form soluble salts, the antimonites and antimonates and thio-antimonates, etc., of which  $\text{Na}_3\text{SbS}_3$  and  $\text{Na}_3\text{SbS}_4$  may be regarded as types. The acids corresponding to these salts, which would be formed by adding  $\text{H}_2\text{SO}_4$  to their solutions, are unstable and decompose—the oxygen acids into water and antimony oxide, and the sulphur acids into hydrogen sulphide and antimony sulphide; thus—



The free sulphur causes the production of antimonious sulphide from the antimonious sulphide (black antimony) employed.

**Characters and Tests.**—Sulphurated antimony is an orange-red powder, readily dissolved by hot hydrochloric acid, with evolution of hydrogen sulphide, and deposition of sulphur. Three grammes placed in a crucible, and moistened and warmed with successive quantities of nitric acid until fully oxidised and red fumes (the reduction products of nitric acid) cease to be evolved, should leave a white residue which, after heating to redness, should weigh from 1.6 to 1.8 grammes. This residue is antimonious oxide,  $\text{Sb}_2\text{O}_3$ , all the antimonious compounds being oxidised to antimonious by the nitric acid, the free sulphur and sulphur of the sulphides being also oxidised and replaced by oxygen. This oxidation and replacement of sulphur by oxygen is the cause of the reduction in weight of the ignited residue, since the  $\text{Sb}_2\text{O}_3$  will obviously weigh less than the  $\text{Sb}_2\text{S}_3$  and  $\text{Sb}_2\text{S}_5$ , from which it has been produced, owing to the atomic weight of oxygen being lower than that of sulphur. The production of a definite quantity of antimonious oxide on oxidising sulphurated antimony is intended to indicate that the substance examined has been made by the official process, since, if made by any other, the proportion of its constituents will be different, and the product will yield a greater or lesser proportion of antimonious

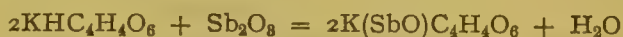
oxide. Sulphurated antimony should only contain the slightest traces of arsenic.

**Notes.**—The reactions involved in the manufacture and testing of sulphurated antimony have considerable importance from an analytical point of view. The solution of the compound in sodium hydroxide contains sodium antimonite, antimonate, thio-antimonite, and thio-antimonate. In all these the antimony forms part of the acidulous radical, and this is in accordance with the weakly basic (electro-positive) character of antimony. The oxides of the less electro-positive metals combine with the stronger bases in this manner, and as a rule the higher oxides of any given metal (compare chromium and manganese) exhibit these acid-forming properties more than the lower oxides. Arsenic and tin form similar soluble compounds, and this property is utilised in analysis to separate the sulphides of As, Sb, and Sn from the other sulphides (Hg, Pb, Cu, Cd, etc.), precipitated simultaneously by  $\text{H}_2\text{S}$  from acid solutions, which do not form similar compounds, and are not, therefore, soluble in ammonium sulphide.

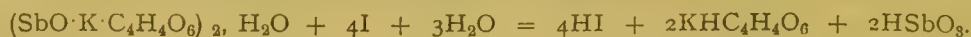
[Dose.—1 to 2 grains.

## Antimonium Tartaratum.

**Tartarated Antimony**, sometimes called Tartar Emetic, is prepared by digesting antimonious oxide with potassium acid tartrate and water until the reaction, which proceeds somewhat slowly, is completed. The reaction-mixture is then boiled with more water, filtered, and the tartarated antimony crystallised from the filtrate.



**Characters and Tests.**—Tartarated antimony occurs in colourless transparent crystals, exhibiting triangular facets; soluble in 17 parts of cold water, and in 3 parts of hot water, forming a slightly acid solution, almost insoluble in strong alcohol, but more soluble in weak alcoholic liquids, such as wines. Taste sweet and metallic. Alkaline hydroxides and carbonates when added to its aqueous solution give precipitates in both cases of hydrated antimonious oxide (antimony carbonate is not produced; compare Antimonii Oxidum) while an insoluble compound is precipitated on the addition of solution of gallo-tannic acid, and also by solution of gallic acid. The quantitative determination for purity is carried out by means of decinormal iodine solution, which oxidises the antimony from the trivalent antimonious condition to the pentavalent antimonie. The calculation is based upon the following reaction—



Now, one formula-weight of tartarated antimony (659·14) contains two antimony atoms, requiring two atoms of oxygen to raise them to the antimonie condition; therefore, 659·14 grammes are equivalent to 503·6 grammes iodine ( $4\text{I} = 503·6$ ). Since the iodine solution employed is decinormal, one litre will be equivalent to  $659·14 \div 40 = 16·48$  grammes of tartar emetic, and 1 C.c. will be, therefore, equivalent to 0·01648 gramme of tartar emetic. The official requirements are that 1 gramme of tartar emetic, under the conditions described,



shall discharge the colour of not less than 60·2 or more than 60·7 C.c. of decinormal iodine solution, and

$$\begin{aligned} 60\cdot2 \text{ C.c. N/10 iodine solution} &= 0\cdot01648 \times 60\cdot2 = 0\cdot992 \text{ gramme tartar emetic.} \\ 60\cdot7 \text{ C.c. N/10 iodine solution} &= 0\cdot01648 \times 60\cdot7 = 1\cdot000 \quad \text{,,} \quad \text{,,} \end{aligned}$$

Therefore, the tartar emetic is required to be practically pure. The conditions for the successful conduct of the titration are (1) the presence of sufficient sodium bicarbonate to neutralise the acids formed, since, when the hydriodic acid formed reaches a certain concentration a condition of equilibrium is produced because the reaction is reversible; and (2) the rapid completion of the experiment, since, on standing, the solution of tartar emetic precipitates some of its antimony as hydrated oxide by the action of the bicarbonate (compare Notes under Antimonii Oxidum). Concerning the use of starch mucilage as indicator of the termination of the reaction, see Notes under Acidum Arseniosum. The meta-antimonic acid, the hydriodic acid, and acid potassium tartrate, shown in the equation, are converted into sodium salts by the sodium bicarbonate. Tartar emetic should show no effervescence when added to solution of sodium bicarbonate; this test excludes adulteration with cream of tartar.

**Notes.**—Tartarated antimony effloresces when exposed to dry air and at 100° C. leaves the anhydrous salt  $\text{K}(\text{SbO})\text{C}_4\text{H}_4\text{O}_6$ . The amount of water lost by the crystals indicates that these contain two molecules of anhydrous salt to one of water, and the formula is sometimes written for the sake of simplicity in calculations,  $\text{K}(\text{SbO})\text{C}_4\text{H}_4\text{O}_6, \frac{1}{2}\text{H}_2\text{O}$ , *i.e.*, half the formula given in the official monograph. [*Dose.*— $\frac{1}{24}$  to  $\frac{1}{8}$  grain (diaphoretic); 1 to 2 grains (emetic).]

## Apomorphinæ Hydrochloridum.

**Apomorphine Hydrochloride**,  $\text{C}_{17}\text{H}_{17}\text{NO}_2, \text{HCl}$ , is the salt obtained on heating morphine with water and hydrochloric acid under pressure. In order to obtain pure apomorphine, the contents of the tube in which the operation is performed are subsequently made alkaline with sodium bicarbonate and shaken with ether. The liberated alkaloid is dissolved out by the ether, which rises to the surface and is separated. To the ethereal solution sufficient strong hydrochloric acid is added to convert the alkaloid into its hydrochloride, which, being insoluble in ether, is precipitated in a crystalline form and may be purified by recrystallisation.

**Characters and Tests.**—Apomorphine hydrochloride forms small, greyish-white, shining, acicular crystals, turning green on exposure to light and air, inodorous. It is soluble in about 60 parts of water, and in 50 of alcohol; when those solutions are boiled some decomposition occurs with production of a green colour. If sodium bicarbonate be added to an aqueous solution the free alkaloid, being only slightly soluble in water, is precipitated, and if the reaction mixture be allowed to stand, the precipitate becomes green. This coloration seems to be accelerated by the presence of alkalies. If the reaction-mixture be now shaken up and divided into three portions the following colour reactions may be observed: on adding ether to one portion, a purple colour; on adding chloroform to another, violet colour; and on adding 90 per

cent. alcohol to the third portion, a bluish-green colour. Two other colour reactions are characteristic of the alkaloid and may be obtained by adding the solid hydrochloride to dilute solution of ferric chloride, which gives a deep red colour, and to strong nitric acid, which gives a blood-red colour. If a 1 per cent. solution of the hydrochloride in water shows an emerald-green coloration after agitation the salt is to be rejected for medicinal use.

**Notes.**—The empirical formulæ for apomorphine, morphine, and codeine show a very simple relationship: morphine,  $C_{17}H_{19}NO_3$ ; codeine,  $C_{17}H_{18}(CH_3)NO_3$ ; apomorphine,  $C_{17}H_{17}NO_2$ . Morphine by the abstraction of  $H_2O$  and codeine by the loss of  $CH_3OH$  both yield  $C_{17}H_{17}NO_2$ . Those alterations are actually produced when morphine and codeine are heated with hydrochloric acid in the sealed tube, but some more fundamental change in constitution must have been simultaneously produced than might be expected from so simple a relationship, since the apomorphine shows entirely different physiological action, and some of its derivatives and decomposition products indicate that its constitution is different to those of morphine and codeine, from which it may be derived. The constitution of these three alkaloids is not yet sufficiently well known to enable any simple explanation of these relationships to be discussed. Although the coloration of solutions of apomorphine may be very distinct, such coloured solutions still retain the properties of the drug, so that it appears as if the decomposition can only have affected a small portion of the alkaloid, although it is rendered so strikingly evident owing to the intense colouring power of the decomposition products. Neutral or faintly acidulated solutions keep best but, wherever possible, solutions of apomorphine should be freshly prepared. Apomorphine never occurs naturally among the opium alkaloids but is always artificially prepared.

[Dose.— $\frac{1}{10}$  to  $\frac{1}{4}$  grain; (hypodermically)  $\frac{1}{20}$  to  $\frac{1}{10}$  grain.]

## Aquæ.

**Waters.**—The preparations of this class consist, with three exceptions, of water impregnated with the aromatic volatile oils obtained by submitting the oil-containing drug to distillation with water and collecting the distillate. It should be noted that the constituents of essential oils are mostly bodies having a boiling-point considerably higher than water, and at the boiling point of water,  $100^\circ C$ . it might be expected that very little, if any, of the oil would come over with the steam. Since, however, essential oils are only so slightly soluble in water the distillation follows the laws which have been found to apply to the distillation of a mixture of immiscible fluids. The following official waters are prepared by distilling the aromatic drug with water:—

Aqua Anethi	Aqua Laurocerasi
" Anisi	" Menthæ Piperitæ
" Aurantii Floris	" Menthæ Viridis
" Carui	" Pimentæ
" Cinnamomi	" Rosæ
" Fœniculi	" Sambuci

All these waters, with the exception of Aqua Laurocerasi, are innocuous, aromatic fluids, used most frequently as solvents or vehicles for the administra-

tion of more potent remedies. No official doses are given since they are harmless.

**Aqua Anethi.** DILL WATER.

Prepared by adding 50 grammes of the dried ripe dill fruit to 1 litre of water and distilling one-half.

**Aqua Anisi.** ANISE WATER.

Prepared by adding 50 grammes of the dried ripe anise fruit to 1 litre of water and distilling one-half.

**Aqua Aurantii Floris.** ORANGE FLOWER WATER.

Prepared by diluting, with twice its volume of distilled water, the so-called "triple" orange-flower water of commerce, prepared by distillation from the flowers of the bitter orange tree, *Citrus aurantium*, var. *bigaradia*, Hooker filius (N.O. Rutaceæ). Orange-flower water should be colourless or possess only a slight yellowish tint. The presence of much colour, an offensive odour, or mouldiness, indicates the presence of organic impurity. The freshly distilled water may possess a somewhat empyreumatic odour and a strong, somewhat acrid taste, but those disappear on keeping. The fragrant odour of the water recalling that of the fresh flowers is due to the volatile oil in solution. The water should also be neutral to litmus paper and be free from copper, lead, or other metallic impurities derived from the solder used in making the tinned copper cans in which the orange-flower water of commerce is imported.

**Aqua Camphoræ.** CAMPHOR WATER.

A saturated aqueous solution of camphor prepared by adding an alcoholic solution of camphor (70 grains in  $\frac{1}{2}$  fluid ounce) to distilled water (1 gallon) in successive portions, shaking after each addition, so as to diffuse the camphor, which is at first precipitated in a cloudy condition; the finely divided camphor dissolves afterwards. This is a more expeditious method and yields also a more uniform product than the process formerly employed, which consisted in submerging crushed camphor in water.

**Aqua Carui.** CARAWAY WATER.

Prepared by adding 50 grammes of the dried caraway fruit to 1 litre of water and distilling one-half.

**Aqua Chloroformi.** CHLOROFORM WATER.

A solution of 1 volume of chloroform in 400 of distilled water. It forms a useful vehicle on account of its warm sweet taste, which serves to mask the taste of nauseous substances. Chloroform is also a powerful antiseptic, so that it forms also a valuable vehicle for, or addition to, the preparations of vegetable drugs, *e.g.*, ergot, which are liable to go mouldy when kept in a diluted condition.

**Aqua Cinnamomi.** CINNAMON WATER.

Prepared by adding 1 pound of the bruised cinnamon bark to 2 gallons of water and distilling one-half.



**Aqua Destillata.** DISTILLED WATER.

Prepared by distillation from good, natural, potable water. See separate monograph below.

**Aqua Fœniculi.** FENNEL WATER.

Prepared by adding 50 grammes of dried ripe fennel fruit to 1 litre of water and distilling one-half.

**Aqua Laurocerasi.** CHERRY-LAUREL WATER.

This differs from the other waters in two respects; first, the volatile constituents do not pre-exist in the drug, but are only formed by the hydrolysis of the glucoside—closely allied to, if not identical with, amygdalin—when the chopped leaves are immersed in the water; secondly hydrocyanic acid is one of the products of hydrolysis so that the distilled product is a distinctly potent fluid. In order to render this potency uniform, the Pharmacopœia directs that its hydrocyanic contents shall be determined by titration with decinormal silver nitrate solution and its strength adjusted, by dilution with water or addition of Acidum Hydrocyanicum Dilutum, so that it shall contain one-tenth per cent. of hydrocyanic acid, HCN. [Dose.— $\frac{1}{2}$  to 2 fluid drachms.

**Aqua Menthæ Piperitæ.** PEPPERMINT WATER.

Prepared by adding 10 C.c. of oil of peppermint to 15 litres of water and distilling two-thirds.

**Aqua Menthæ Viridis.** SPEARMINT WATER.

Prepared by adding 10 C.c. of oil of spearmint to 15 litres of water and distilling two-thirds.

**Aqua Pimentæ.** PIMENTO WATER.

Prepared by adding 25 grammes of the bruised, dried, full-grown, unripe pimento fruit to 1 litre of water and distilling one-half.

**Aqua Rosæ.** ROSE WATER.

Prepared by diluting, with twice its volume of distilled water the so-called "triple" rose water of commerce, prepared by distillation from the flowers of *Rosa damascena*, Linné (N.O. Rosaceæ).

**Aqua Sambuci.** ELDER FLOWER WATER.

Prepared by adding 200 grammes of the fresh flowers of *Sambucus nigra*, Linné (N.O. Caprifoliaceæ)—or an equivalent quantity of the flowers preserved, while fresh, with common salt—to 1 litre of water and distilling one-fifth.

## Aqua Destillata.

**Distilled Water** is prepared by distilling ordinary clean tap or spring water. It is advisable to reject the first portions of the distillate if these show a deep yellow tint when tested with Nessler's reagent, and distillation should be discontinued before the residue in the still becomes so small that there is risk of charring the traces of organic matter which are always present in ordinary water.

**Characters and Tests.**—Distilled water should be colourless, tasteless, and odourless. Evaporated in a platinum capsule 25 C.c. should leave a hardly perceptible residue. It should afford negative results when tested for metals, chlorides, nitrates, nitrites, or sulphates, and should be neutral to litmus paper. Absence of more than traces of organic matter is tested for in the following manner: to 100 C.c. of the water, in a thoroughly cleansed flask having a capacity of about 250 C.c., add 1 C.c. of diluted sulphuric acid and then 0.1 C.c. of a mixture of one part of the official solution of potassium permanganate with 2 parts of water. Boil the mixture for three minutes, then cover the mouth of the flask with a clean watch glass or crucible lid and set aside for 1 hour. At the end of this period the contents of the flask should retain a distinct pink tint showing that organic matter is not present in sufficient quantity to reduce, and therefore decolorise, the minute quantity of potassium permanganate employed. It is also required that Aqua Destillata shall contain not more than 0.005 parts of ammonia per million parts. In order to determine the presence of such a minute proportion, an exceedingly delicate reaction yielded by ammonia with Nessler's reagent is employed in the following way. Place two clean Nessler glasses on a white porcelain plate. Into one pour 100 C.c. of the water to be tested and add 2 C.c. of solution of potassium-mercuric iodide (Nessler's reagent). If no ammonia be present the mixture remains colourless, but if ammonia be present a yellow colour develops on standing a few minutes, the depth of colour being proportional to the quantity of ammonia present. Now prepare a solution containing 0.005 parts of  $\text{NH}_3$  per million by adding 0.25 C.c. of the special solution of ammonium chloride (containing 3.15 grammes of  $\text{NH}_4\text{Cl}$  per litre) to 1,000 C.c. of ammonia-free water, and then diluting 10 C.c. of this solution to 500 C.c. with more ammonia-free water. Thoroughly agitate this mixture and pour it into the second Nessler glass to exactly the same depth as that occupied by the sample of water to be tested. Add 2 C.c. of Nessler's reagent and after a few minutes compare the depth of tint in the two glasses by looking through them from above on to the white porcelain surface below. Under these circumstances the yellow tint given by the water to be tested should be less intense than that of the prepared water in the second Nessler glass.

**Notes.**—The permanganate test is a variety of one commonly employed by analysts in determining the suitability of water for domestic purposes, and known sometimes as the moist combustion process because it depends upon the oxidation of the organic matter by the permanganate. For the purpose of comparison the results are usually stated in terms of oxygen consumed, grains per gallon, or parts per million, the calculation being based upon the fact that 2 mol. wts.  $\text{KMnO}_4$  (313.74) yields 5 atoms of oxygen ( $5 \times 15.88$ ) available for oxidation in acid solution. In carrying out the test great attention must be paid to the cleanliness of all the utensils since one is dealing with very minute amounts of the reacting substances and sufficient foreign matter may easily be introduced to vitiate the results. It is also usual to test the diluted sulphuric acid employed (to prove that this does not contain traces of sulphurous acid or other substances which exert a reducing effect upon the permanganate) by

slightly tinting about 50 C.c. with a dilute solution of permanganate and observing that the colour is not discharged. The test for ammonia is also employed in the analysis of water for domestic purposes, the presence of ammonia or ammonia-yielding compounds in more than certain minute traces being held to indicate contamination of the water with sewage or other organic débris. Since ammonium salts are so commonly employed in the laboratory, great care must be exercised in order to prevent the accidental introduction of them during the performance of the test. All the appliances should be flushed out immediately before use with a plentiful supply of clean tap water, and the preparation of the comparison-solutions of ammonia must be accomplished with ammonia-free distilled water. To obtain water in this condition the still and its connections must be thoroughly cleansed and charged with fresh water. Distillation should be then started and the distillate collected in portions of about 50 C.c. and rejected until they cease to give the faintest yellow tint on the addition of Nessler's reagent. The yellow tint produced in very weak ammonia solutions is due to the formation of dimercuric-ammonium iodide,  $\text{NHg}_2\text{I}$ , which may be regarded as derived from ammonium iodide,  $\text{NH}_4\text{I}$ , by the substitution of two divalent mercury atoms for four univalent hydrogen atoms. In stronger solutions of ammonia Nessler's reagent produces a brown precipitate of dimercuricammonium iodide. It is necessary to distinguish carefully between Mayer's reagent and Nessler's reagent. They both contain the double iodide of mercury and potassium, obtained by adding solution of mercuric chloride to solution of potassium iodide in certain proportions: Nessler's reagent, however, is made strongly alkaline with sodium hydroxide. Mayer's reagent is employed as a reagent for alkaloids. In the Pharmacopœia, Nessler's reagent is called solution of potassio-mercuric iodide. It is usual to keep two ammonia solutions for comparison purposes in the Nessler test: one containing 3.15 grammes  $\text{NH}_4\text{Cl}$  per litre, and a weaker one obtained by diluting 1 volume of this to 100 with water. Since  $\text{NH}_4\text{Cl}$  (mol. wt. 53.5), yields  $\text{NH}_3$  (mol. wt. 17) the stronger solution will contain 1 gramme  $\text{NH}_3$  per litre or 0.001 gramme per C.c.; for—

$$53.5 \quad : \quad 17 \quad :: \quad 3.15 \quad : \quad 1$$

while the weaker one will contain 0.00001 gramme per C.c., *i.e.*, 1/100 Mgm.

## Araroba.

**Goa Powder** or **Crué Chrysarobin** is a substance found in longitudinal fissures in the trunk of *Andira Araroba*, Aguiar (N.O. Leguminosæ), a large tree common in the damp forests of Bahia, Brazil. The powder appears to be a pathological product, formed by the breaking down of the walls of parenchymatous and prosenchymatous cells, and vessels; the resulting cavities, which are found filled with araroba, are often of considerable size. When a tree is felled, the trunk is sawn into lengths which are split longitudinally, after which the yellowish powder in the cavities is scraped out, mixed with fragments of wood and other débris. It is roughly purified by sifting to remove foreign matters, and is then dried and powdered. Another method of purification is to



grind the crude drug, exhaust it by boiling with chloroform or benzene, evaporate the solution to dryness, and powder the residue; but an active constituent is said to be left in the exhausted drug after treatment by this method, being insoluble in chloroform or benzene.

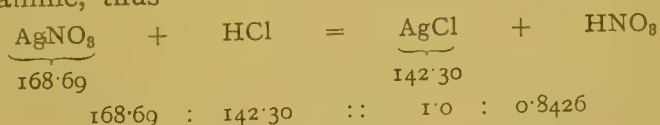
**Characters and Tests.**—Goa powder varies in colour, from brownish-yellow to umber-brown, according as it consists more or less of chrysarobin free from impurities. It melts when heated, giving off yellow fumes, and finally burns, leaving not more than 1 per cent. of ash. The powder should yield not less than 50 per cent. of chrysarobin on treatment with hot chloroform.

**Notes.**—Much of the purified araroba of commerce is said to be obtained by exhausting the crude drug with an aqueous solution of a caustic alkali and subsequently precipitating the filtered liquid by adding an acid. The chief constituents of the drug are chrysarobin and dichrysarobin methyl ether, but small quantities of dichrysarobin and another substance soluble in chloroform are also present.

## Argenti Nitras.

**Silver Nitrate** or **Lunar Caustic**,  $\text{AgNO}_3$ , is prepared by the action of nitric acid on silver.

**Characters and Tests.**—Silver Nitrate forms colourless tabular crystals. It is soluble in less than its own weight of water, slightly soluble in strong alcohol, also soluble in ether and glycerin. It affords the reactions characteristic of silver and of nitrates. One gramme dissolved in 15 C.c. of water gives, on the addition of slight excess of hydrochloric acid, a white precipitate of silver chloride, which, when thoroughly washed and dried, should weigh 0.843 gramme, thus—



The official requirements indicate, therefore, a practically pure salt. Since the filtrate should contain nothing but the nitric acid and the slight excess of hydrochloric acid, it should leave no residue when evaporated to dryness on a water-bath. Silver nitrate should be free from lead, copper, iron, sodium, potassium, or sulphates. [Dose.— $\frac{1}{4}$  to  $\frac{1}{2}$  grain.]

## Argenti Nitras Induratus.

**Toughened Caustic** is prepared by melting together 95 parts of silver nitrate and 5 parts of potassium nitrate in a platinum or porcelain crucible, and pouring the melted mass into suitable moulds to solidify.

**Characters and Tests.**—Toughened caustic occurs in white or greyish-white cylindrical rods or cones; it is freely soluble in water, but only slightly soluble in 90 per cent. alcohol. It affords the reactions characteristic of silver, potassium, and nitrates. One gramme treated as described under the tests for

Argenti Nitras should yield 0·8 gramme of silver chloride. The filtrate in this case will contain potassium nitrate, and hence will yield a white saline residue on evaporation.

**Notes.**—Pure silver nitrate when fused and cast into moulds yields sticks which are too brittle for use as “Caustic.” The addition of 5 per cent. of potassium nitrate imparts the necessary toughness.

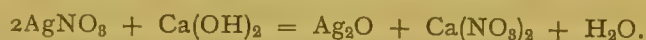
### Argenti Nitras Mitigatus.

**Mitigated Caustic** is composed of 1 part silver nitrate and 2 parts of potassium nitrate, melted together in a platinum or porcelain crucible and cast into moulds.

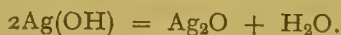
**Characters and Tests.**—Mitigated caustic resembles toughened caustic in characters, and should comply with the same qualitative tests. Owing, however, to the presence of the potassium nitrate it will yield only one-third as much silver chloride as pure silver nitrate, *i.e.*, 3 grammes will yield 0·843 gramme of AgCl.

### Argenti Oxidum.

**Silver Oxide**,  $\text{Ag}_2\text{O}$ , may be prepared by adding solution of calcium hydroxide (lime water) to solution of silver nitrate, thus—

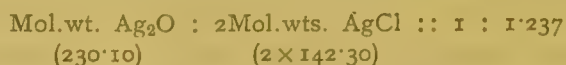


Silver hydroxide,  $\text{Ag}(\text{OH})$  only exists at very low temperatures; it is not, therefore, obtained in the present case, but decomposes at once into oxide and water, thus—



This method is not employed commercially, caustic alkalies being used to precipitate the silver oxide; the precipitate in this case carries down some of the alkaline hydroxide with it, which is only removed with difficulty by prolonged washing. The silver oxide after precipitation should be rapidly collected, washed, and dried on a water bath, as it is easily decomposed into silver and oxygen at higher temperatures.

**Characters and Tests.**—Silver oxide is a brown powder which, at a low red heat, gives off oxygen and leaves a white residue of metallic silver. It dissolves in nitric acid, forming the nitrate without the evolution of any reddish nitrous fumes, such as would be produced if any metallic silver were present. The presence of metallic silver would be due to overheating in drying or careless storage, since the oxide is easily reduced to metal by contact with organic matter. One gramme dissolved in nitric acid, the solution being diluted, and then precipitated with hydrochloric acid, as described under Argenti Nitras, yields 1·237 grammes of silver chloride.



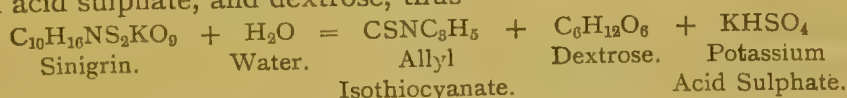
Silver oxide should be free from lead, copper, or iron. It is so readily reduced that when mixed with phenol, creosote, potassium permanganate, and many other substances, it decomposes with explosive violence. [*Dose.*— $\frac{1}{2}$  to 2 grains.]

## Armoraciæ Radix.

**Horseradish Root** is obtained from *Cochlearia Armoracia*, Linné (N.O. Cruciferae), a plant indigenous to Eastern Europe, but naturalised in Britain, and cultivated there and elsewhere. The fresh roots of cultivated plants are alone official. The plant has a long root which is enlarged and somewhat conical at the top, but nearly cylindrical throughout the greater part of its length and tapering towards the extremity. The root is obtainable in the fresh state all the year round, but it is most active in the autumn and early spring, before the leaves have appeared.

**Characters.**—Horseradish root is nearly cylindrical in shape, but somewhat enlarged at the crown, where it is marked with closely approximated leaf-scars which almost encircle the crown (semi-amplexicaul). The root has very few branches, and is marked with a few transverse markings. It measures from 12 to 25 Mm. in diameter and 30 Cm. or more in length. Externally it is pale yellowish-white or brownish-white; internally, whitish. It is inodorous when unbroken, but distinguished by a characteristic pungent odour, due to the formation of a volatile oil identical with that of black mustard seed, when the root is scraped or bruised. The pungent taste of the root is also due to the formation of volatile oil.

**Notes.**—The distinctive characters of horseradish root are its pale yellowish colour, cylindrical shape, pungent odour when scraped, and pungent taste. The root contains sinigrin or potassium myronate—a crystalline glucoside which is decomposed in the presence of water by myrosin, an enzyme also found in the root, the products of the reaction being allyl isothiocyanate (volatile oil), potassium acid sulphate, and dextrose, thus—



The reaction does not take place in the root under normal conditions, because the sinigrin and myrosin exist in separate cells. The root yields about 0.05 per cent. of the volatile oil; it also contains resin, sugar, and starch.

## Arnicae Rhizoma.

**Arnica Rhizome or Root** consists of the dried rhizome and rootlets of *Arnica montana*, Linné (N.O. Compositae), a small plant indigenous to Central Europe. Like other rhizomes and roots used for medicinal purposes, to obtain arnica in the best condition it should be collected in the autumn, after the flowering stem has died down, or in the spring, as soon as the new plant makes its appearance above ground and before the leaves appear.

**Characters.**—Arnica has a cylindrical, horizontal, dark-brown rhizome, which is curved, rough, from 2.5 to 5 Cm. in length, and from 4 to 6 Mm. in thickness. At intervals the rhizome may give off branches which give it a jointed appearance; it also bears on its under surface numerous brittle, wiry rootlets, and on the upper surface are found scars encircling the rhizome (amplexicaul), indicating where scales or cataphyllary leaves have fallen off. The



rhizome is usually terminated by the hairy remains of the stem and leaves. The faintly aromatic, apple-like odour of the drug is due to the volatile oil it contains, the bitter acrid taste being due to arnicin. Ash-yield, about 8 to 10 per cent.

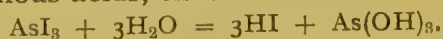
**Notes.**—The distinctive characters of arnica are the curved rhizome with wiry rootlets, and the appearance of a transverse section of a rhizome or root—a thick whitish or yellowish bark encircling a ring of dark oleo-resin ducts near the yellowish wood. In addition, the rhizome has a large whitish pith and broad medullary rays. It breaks with a short fracture, is often discoloured internally, and is shrivelled longitudinally. The drug contains about 0.5 per cent. of volatile oil, a bitter and acrid principle named arnicin, also tannin, inulin, etc. Starch is absent, a distinction being thus afforded between arnica and any starch-containing rhizome.

## Arsenii Iodidum.

**Arsenious Iodide**,  $\text{AsI}_3$ , is obtained by the direct combination of the elements—arsenium and iodine.

**Characters and Tests.**—Arsenious iodide should be in small orange-coloured crystals, soluble in water and 90 per cent. alcohol. Its aqueous solution affords the reactions characteristic of arsenium and of iodides, but is not neutral to litmus. When heated in a test tube the solid salt is decomposed, violet vapours of iodine being set free.

**Notes.**— $\text{AsI}_3$  is a weak compound and decomposes, in contact with water, into hydriodic and arsenious acids, thus—



The behaviour of the compound in this respect should be compared with that of the halogen phosphorus compounds. [Dose.— $\frac{1}{20}$  to  $\frac{1}{5}$  grain.]

## Asafetida.

**Asafetida** is a gum resin obtained from the root of *Ferula foetida*, Regel (N.O. Umbelliferæ), and probably other species growing in Eastern Persia and Western Afghanistan. The cortex of the stem and root contains numerous large schizogenous ducts, filled with a milky emulsion; on incision, or on cutting off the stem close to the crown of the root, the milky juice exudes and hardens to form the gum-resin, which is collected and conveyed to Bombay, whence it is exported to Europe. The drug occurs in commerce in more or less agglutinated tears, but ordinary lump asafetida is excluded by the official description.

**Characters and Tests.**—Asafetida should be in rounded or flattened tears, from 12 to 25 Mm. in diameter, or in masses of agglutinated tears. The dull yellow colour of the fresh tears darkens on keeping, ultimately changing to reddish-brown. They are usually tough at ordinary temperatures, becoming harder when cooled and softer when warmed. Internally the tears may be yellowish and translucent, or milky white and opaque, the difference in that respect probably depending upon the relative freedom from moisture. The freshly exposed surfaces of broken tears gradually assume a pink colour, which

changes to red and finally to reddish-brown, probably owing to oxidation of the volatile oil present. The strong, persistent, alliaceous odour, and bitter, acrid, alliaceous taste are due to the volatile oil and resin. When triturated with water, asafetida forms a white emulsion, as it contains both resin and gum. The fine green colour assumed by the freshly-fractured surface of a tear when touched with 35 per cent. nitric acid distinguishes asafetida from galbanum. It is distinguished from ammoniacum by containing umbelliferone, or a substance yielding it, a blue fluorescence being produced when a small fragment of the drug is strongly heated in a dry test-tube, and, after cooling, treated with boiling water, the solution thus obtained being subsequently largely diluted with cold water, and made alkaline with solution of ammonia. Asafetida should contain not less than 50 per cent. of matter soluble in 90 per cent. alcohol, and should yield not more than 15 per cent of ash when incinerated.

**Notes.**—Umbelliferone,  $C_9H_6O_3$ , the anhydride of umbellic acid, is an oxycoumarin; it has an odour resembling that of coumarin (cumaric anhydride), behaves similarly with potassium hydroxide, and shows a blue fluorescence when dissolved in dilute alkalis. It also occurs in African ammoniacum and galbanum. In Dieterich's test for umbelliferone, which is more delicate than that of the Pharmacopœia, 5 grammes of the suspected substance is boiled for fifteen minutes with 15 C.c. of strong hydrochloric acid, then diluted with 15 C.c. of water, after which the liquid is filtered. Any umbelliferone present is split off from its natural ester and causes an intense blue fluorescence in the clear filtrate when that is supersaturated with ammonia. The chief constituent of asafetida is an ether-soluble resin—the ferulic, or ferulaic, acid ester of asa-resinotannol—of which it may contain more than 60 per cent. The resin yields umbelliferone on dry distillation, and is converted into resorcin and protocatechuic acid when fused with potassium hydroxide. The drug also contains a small quantity of resin—free resinotannol—which is insoluble in ether, 20 to 30 per cent. of gum, and 3 to 9 per cent. of a volatile oil containing 20 to 25 per cent. of sulphur, probably in the form of hexenyl sulphide and disulphide. Other constituents of asafetida are free ferulic (ferulaic) acid, moisture, and various impurities, such as calcium sulphate and carbonate, sand, stones, etc. Fine tears yield only about 3 to 5 per cent. of ash.

[Dose.—5 to 15 grains.

## Atropina.

**Atropine** is an alkaloid,  $C_{17}H_{23}NO_3$ , obtained from the leaves or root of *Atropa Belladonna*, Linné (N.O. Solanaceæ), and other species. It may be extracted by exhausting the drug with alcohol, reducing the bulk of the resulting tincture by distillation, and adding diluted sulphuric acid in slight excess to decompose the alkaloidal salt in solution. The liquid is then evaporated to small bulk and filtered after the addition of an equal quantity of water. Solution of potassium hydroxide in slight excess is next added to decompose the sulphate which has been formed, and the liberated alkaloid is then shaken out with chloroform; finally, the chloroformic solution is allowed to evaporate spontaneously, the atropine being left in the form of crystals.

**Characters and Tests.**—Atropine (melting point  $115^{\circ}$  to  $115.5^{\circ}$  C.) occurs in colourless acicular crystals which are officially stated to be soluble in 300 parts of water, readily soluble in 90 per cent. alcohol (1 in 3), in chloroform (1 in 1), and in ether (1 in 25). An aqueous solution of the base has an alkaline reaction and a bitter taste; when applied to the eye it dilates the pupil powerfully. An alcoholic solution warmed with test solution of mercuric chloride gives a yellow precipitate, which soon turns red. The base is distinguished from hyoscyamine by giving with solution of auric chloride a citron-yellow precipitate which has a minutely crystalline character when recrystallised from boiling water acidulated with hydrochloric acid, and a dull pulverulent appearance when dry. The residue left on moistening atropine with fuming nitric acid and evaporating the mixture to dryness on a water-bath should give a fugitive reddish-violet coloration with freshly prepared alcoholic solution of potassium hydroxide. The alkaloid leaves no ash when burned with free access of air, the absence of any foreign mineral matter being thus indicated.

**Notes.**—The alkaloid contained in belladonna appears to be primarily hyoscyamine, but that base becomes converted into its isomer atropine by the action of the heat and alkali used during the processes of extraction, precipitation, etc. Commercial atropine frequently contains traces of unconverted hyoscyamine and the best and simplest test for determining its freedom from that base is its optical inactivity. According to Squire the solubility of atropine in water is only 1 in 500. [Dose.— $\frac{1}{200}$  to  $\frac{1}{100}$  grain.]

## Atropinæ Sulphas.

**Atropine Sulphate**,  $(C_{17}H_{23}NO_3)_2H_2SO_4$ , may be prepared by neutralising atropine with diluted sulphuric acid.

**Characters and Tests.**—Atropine sulphate (melting point  $183^{\circ}$  to  $190^{\circ}$  C.) is a colourless amorphous-looking but crystalline substance, officially stated to be soluble in 10 parts of 90 per cent. alcohol and in 1 part of cold water, forming solutions which are neutral to litmus and dilate the pupil of the eye, even when considerably diluted. The sulphate is insoluble in ether or in chloroform. It yields the characteristic tests for sulphates, and a saturated aqueous solution of the salt yields with solution of sodium carbonate a white precipitate which, when separated, responds to the tests for atropine. The sulphate leaves no ash when burned with free access of air, the absence of any foreign mineral matter being thus indicated.

**Notes.**—Though officially described as nearly colourless, atropine sulphate can be obtained quite free from colour. The melting point of the salt is about  $185^{\circ}$  to  $186^{\circ}$  C., rather than  $183^{\circ}$ ; the solubility of the salt in 90 per cent. alcohol is 1 in 4 and its solubility in water 2 in 1. It should be observed that the test with mercuric chloride is only given by the free alkaloid and not by its salts, since the production of the coloured mercuric oxysalt or oxide is due to the alkaline reaction of the alkaloid. [Dose.— $\frac{1}{200}$  to  $\frac{1}{100}$  grain.]



## Aurantii Cortex Recens.

**Fresh Bitter Orange Peel** is the fresh outer part of the pericarp of the Seville orange, the fruit of *Citrus Aurantium*, var. *Bigaradia*, Hooker filius (N.O. Rutaceæ), a small tree which is grown especially in the countries bordering on the Mediterranean. The fruit is a superior, polycarpellary syncarpous berry (hesperidium), pulpy within and covered externally with a tough rind or pericarp. It is collected and exported before it is quite ripe, the process of ripening being completed during the voyage from the south of Spain (Seville), whence the best oranges for medicinal purposes come, or from Sicily (Palermo). The rind of the fruit consists of a thin exterior layer abounding in vesicles filled with a fragrant volatile oil, and a thick, white, spongy interior layer (mesocarp), which is insipid and inodorous. The outer part of the rind alone is official, and is usually removed from the fruit after it arrives in this country, care being taken to avoid rupturing the oil-glands, which occur in the epicarp. The fresh peel is not readily obtainable except during February, March and April.

**Characters.**—Bitter orange peel is deep orange-red or red in colour externally, and generally rough and glandular, the glands containing the volatile oil. The peel of the bitter orange should have but a very small portion of the white, spongy “zest” or mesocarp attached, as that is lacking in bitterness. The pleasant aromatic odour of the peel is due to the volatile oil it contains, and the bitter taste to aurantiummarin. Ash-yield, 3·5 to 6·5 per cent.

**Notes.**—The peel of the sweet orange, *Citrus Aurantium*, Linné, which is sometimes substituted for bitter orange peel, is usually paler, more yellow in colour, thinner and smoother. The chief constituent of bitter orange peel is a volatile oil (specific gravity, 0·848 to 0·852), which consists of about 90 per cent. of d-limonene (hesperidene), together with various aldehydes and esters. It appears to differ from the volatile oil of sweet orange peel in odour and taste only. The peel contains about 1·5 to 2·5 of an amorphous principle, named aurantiummarin. Other constituents of the peel are the two colourless, tasteless, crystalline glucosides—hesperidin and isohesperidin, a colourless, tasteless, substance named hesperic acid, and aurantiummaric acid—a bitter principle of secondary importance.

## Aurantii Cortex Siccatus.

**Dried Bitter Orange Peel** is the dried outer part of the pericarp of *Citrus Aurantium*, var. *Bigaradia*, Hooker filius (N.O. Rutaceæ), and is largely imported from Malta and Spain, the Maltese product forming the bulk of the imports.

**Characters.**—Dried bitter orange peel should be in thin strips, the outer surface of which is deep orange-red in colour, rough and glandular. As in the case of the fresh peel, and for the same reason the dried peel should be as free as possible from the white spongy portion of the pericarp.

The odour and taste resemble those of the fresh peel, but the dried peel is less aromatic.

**Notes.**—The distinctive characters of dried bitter orange peel are its orange-red colour, bitter taste, and rough outer surface. Sweet-orange peel is much lighter in colour, thinner, smoother, and much less bitter in taste.

## Balsamum Peruvianum.

**Balsam of Peru** is the product of *Myroxylon Pereira*, Klotzsch (N.O. Leguminosæ), a tree which grows in various parts of Central America, particularly in the forests of San Salvador, on the so-called "balsam coast." Though the bark of the young twigs of the tree contain schizogenous secretion ducts, those are soon thrown off, and no fresh ones are formed. The balsam, therefore, is probably not a normal secretion, but a pathological product, the formation of which is caused by beating the bark and stimulated by subsequent scorching with torches. The exuding thick resinous liquid is absorbed by cotton rags inserted beneath the loosened bark, and afterwards separated by boiling the saturated pads with water and straining, or the balsam is allowed to deposit by standing. It owes its name to the fact that it was originally exported by way of Peru, but it is now shipped from Acajutla and Belize, *via* New York and Hamburg.

**Characters and Tests.**—Balsam of Peru is a viscid liquid (specific gravity 1.140 to 1.150) which appears nearly black in bulk, but in thin layers it appears transparent and of a deep orange-brown or reddish-brown colour. It has a fragrant, agreeable odour and an acrid taste, a burning sensation being left in the throat after swallowing the drug. The balsam is practically insoluble in water, which only dissolves a little of the cinnamic acid present and traces of benzoic acid, but it is soluble in all proportions in chloroform. Mixed with an equal volume of 90 per cent. alcohol a clear solution is formed, but when the alcohol is added in the proportion of more than 3 to 1 of balsam the mixture becomes turbid. The cause of the turbidity does not appear to have been explained. The absence of copaiba and resins, with which the balsam is sometimes adulterated, is indicated by the production of a permanently soft mixture on triturating 10 drops of the balsam with 0.4 gramme of lime; on warming the same mixture until all volatile matter is driven off and charring commences, a fatty odour will be perceived if castor oil or other fatty oil be present. If ethylic alcohol has been added to the balsam, the specific gravity will be lowered, and on shaking the drug with an equal bulk of water a diminution in volume will be caused by the water removing the alcohol. On treating the balsam with three times its volume of carbon bisulphide, about 40 per cent. of resin should separate, and the clear supernatant liquid should be of a pale brown colour with only a slight fluorescence, thus indicating the absence of gurjun oil; if the latter be present a violet coloration will be produced on adding one drop of a freshly-prepared and cooled mixture of nitric and sulphuric acids to 20 drops of the liquid, but a similar colour is occasionally

yielded by genuine balsams. As a quantitative test, 5 grammes of balsam of Peru should yield from 2.85 to 3 grammes of aromatic, oily residue, after shaking with 5 C.c. of sodium hydroxide solution (specific gravity 1.16) to remove resin, then washing with three successive quantities (15 C.c. each) of purified ether to dissolve out the cinnamein and other aromatic bodies. After separation and evaporation of the ether, the residue should be cautiously dried until the loss in weight, in two weighings at five minutes' interval, does not exceed 1 Cgm. The oily residue should require from 11.9 to 12.8 C.c. of normal volumetric alcoholic solution of potassium hydroxide to decompose the esters of cinnamic and benzoic acids (benzyl cinnamate and benzoate) present, 20 C.c. of the volumetric solution being added to the residue, together with 40 C.c. of 90 per cent. alcohol, and saponification effected by heating the whole under a reflux condenser for one hour, after which the amount of uncombined alkali can be determined by titration with volumetric solution of sulphuric acid.

**Notes.**—The specific gravity of balsam of Peru is lowered by the addition of alcohol, fixed oils, turpentine, copaiba, etc. The lime test and other qualitative tests are unsatisfactory; thus, it is found that absolutely pure balsam of Peru becomes quite hard on keeping, whether lime be added or not, but that the addition of a little liquid paraffin results in the production of a permanently soft mass. Balsam which does not harden, therefore, even after lime has been added, is probably not pure. The quantitative determination of the resin and aromatic constituents affords more information, both regarding probable adulteration and the actual value of the drug. The chief constituent of the balsam is from 56 to 66 per cent. of cinnamein—a colourless, aromatic oil which consists of benzyl benzoate, mixed with a smaller proportion of benzyl cinnamate, both of these esters being colourless, crystalline, aromatic bodies; other constituents of the balsam are an alcohol (peruvial) with a sweet odour and taste, traces of vanillin and free cinnamic acid, and about 28 per cent. of resin, consisting of peru-resinotannol combined with cinnamic and benzoic acids. The term "balsam," it may be noted, is properly limited to oleo-resinous substances containing cinnamic or benzoic acid. [Dose.—5 to 15 minims.

## Balsamum Tolutanum.

**Balsam of Tolu** is obtained from the trunk of *Myroxylon Toluifera*, H. B. and Kunth (N.O. Leguminosæ), a native of New Granada. As in the case of *M. Pereira*, the twigs of *M. Toluifera* contain schizogenous secretion ducts, which are soon thrown off and not replaced; the bark of the trunk contains no secretory tissue, and the balsam appears to be a pathological product formed by the transformation of part of the young wood or bark tissue, as a result of incisions made in the tree. The balsam flows from those incisions, and is collected in gourds, which are subsequently emptied into skin bags or tins, the shape of which is assumed by the soft, tenacious, yellowish-brown, resinous mess. The balsam derives its name from Tolu, a small town near Cartagena, and is exported chiefly from Savanilla and other Colombian ports, viâ New York.

**Characters and Tests.**—Balsam of tolu is a soft and tenacious solid when first imported, but gradually hardens on keeping to a brownish, brittle.



and easily powdered mass (specific gravity, 1.230 to 1.258). The brittleness is more pronounced in cold weather, but when warmed the hardened balsam readily softens. In thin films it appears transparent and of a yellowish-brown colour; if a small piece be warmed and pressed between two glass slides, so that a very thin film is obtained, on examining the specimen with a lens or microscope numerous colourless crystals of cinnamic acid and some vegetable débris can be seen, imbedded in a transparent mass. The aromatic constituents of the balsam impart to it an agreeably fragrant odour, which is especially marked when the drug is warmed; the taste is also somewhat aromatic and slightly acid. The balsam is soluble in its own bulk of 90 per cent. alcohol or glacial acetic acid, in half as much chloroform, and in three times its bulk of benzene, but it is insoluble in petroleum spirit, and nearly so in carbon bisulphide, yielding cinnamic acid principally to the last named solvent. The alcoholic solution has an acid reaction, owing to the presence of cinnamic and benzoic acids. If 5 grammes of the balsam be gently warmed with two successive portions of 25 and 10 C.c. of carbon bisulphide, and the mixed solutions evaporated, the crystalline residue of benzoates and cinnamates left should require not less than one-third of its weight of potassium hydroxide for saponification.

**Notes.**—The distinctive characters of balsam of tolu are its odour, taste, and slight solubility in carbon bisulphide. The solubility test is particularly important, as the balsam may be adulterated with resinous substances soluble in carbon bisulphide; such substances will leave a resinous instead of a crystalline residue, and require less potassium hydroxide to effect complete saponification. The balsam is more liable to adulteration than balsam of Peru; among the substances which have been employed as adulterants are exhausted balsam of tolu and dried Canada turpentine or “balsam,” as it is usually, but incorrectly, termed. Balsam of tolu contains about 12 to 15 per cent. of free acid (mainly cinnamic), traces of vanillin, and about 7.5 per cent. of cinnamein—an aromatic, oily liquid, consisting of benzyl benzoate mixed with a smaller proportion of benzyl cinnamate. The resinous portion of the drug, amounting to about 80 per cent., yields on saponification an alcohol (tolu-resinotannol) and cinnamic acid, together with a little benzoic acid. [*Dose.*—5 to 15 grains.]

## Belladonnæ Folia.

**Belladonna Leaves** are obtained from the deadly nightshade, *Atropa Belladonna*, Linné (Solanaceæ), a tall branching herb with a perennial root, which is widely distributed over Central and Southern Europe, and cultivated for medicinal purposes in the South of England and Germany. The fresh leaves, with the branches to which they are attached, must be collected when the plant is in flower, as they are then richest in alkaloid.

**Characters.**—Belladonna leaves have short stalks, and the lower ones are arranged alternately, but the upper leaves are in unequal pairs. In shape they are broadly ovate, varying from oval-lanceolate to ovate-lanceolate, acute at the apex, entire at the margin, and tapering at the base into a slightly-winged petiole. They vary in length from 8 to 20 Cm., and appear quite glabrous as

a rule, though a few hairs may usually be found near the midrib, while on the pedicel and calyx of the flowers and on the upper portion of the stem hairs occur in abundance. The midrib of the leaf is prominent below, but depressed on the upper surface, and a transverse section of the leaf, when examined under the microscope, exhibits bi-collateral bundles in the midrib, strands of bast occurring both above and below the wood. The lateral veins leave the midrib at an angle of about  $45^{\circ}$  to  $60^{\circ}$ . The fresh leaves are somewhat fleshy, and the mesophyll contains numerous very minute sandy crystals of calcium oxalate; when the leaf is dried, the shrinkage of the tissue causes the cells filled with the crystals to appear as whitish prominences when examined with a lens. The corolla is gamopetalous (the petals cohering laterally), bell-shaped, and of a dingy purple colour. Ash-yield, about 14 per cent.

**Notes.**—Carefully dried belladonna leaves should be of a pale greyish-green hue rather than brownish, also very thin and brittle. Dried stramonium leaves somewhat resemble them, but they become curled and twisted as they dry; their lateral veins make a more acute angle with the midrib than those of belladonna, and they have a characteristic disagreeable odour. Foxglove and henbane leaves are readily distinguished from belladonna leaves, as they are both hairy. The chief constituents of belladonna leaves are the alkaloids hyoscyamine and atropine; the proportion of total alkaloid present in the dried leaves should be 0.3 to 0.4 per cent., but as much as 1 per cent. has been found, the greater proportion consisting of hyoscyamine. Belladonnine (oxyatropine) and other alkaloids of less importance are also present in small quantity, together with various other compounds, including  $\beta$ -methyl- $\alpha$ -sculetin (scopoletin or chrysotropic acid), a fluorescent principle which is also found in gelsemium root.

## Belladonnæ Radix.

**Belladonna Root** is obtained from *Atropa Belladonna*, Linné (N.O. Solanaceæ), usually from plants cultivated in England or Germany. The stout, branching tap-root is collected in the autumn when about three or four years old, and carefully dried. Both old and exhausted roots are excluded by the official description.

**Characters.**—Belladonna root should be in nearly cylindrical pieces, varying in diameter from 10 to 20 Mm., and in length from 15 to 30 Cm. or more. It is of a pale greyish-brown colour externally, finely wrinkled or striated longitudinally, is often marked with short transverse scars, and frequently has a powdery or mealy surface, owing to the thin epidermis being easily abraded and starchy matter beneath becoming detached. The transverse fracture is short, and not at all fibrous, while the interior of the root is whitish, owing to the presence of small compound starch-grains in the parenchymatous cells of both bark and wood. Other cells are filled with numerous, very minute, sandy crystals of calcium oxalate, both those and the muller-shaped starch-grains being revealed under the microscope. A transverse section of a young root exhibits a greyish non-fibrous bark, separated by a dark cambium layer from the whitish wood, to which it adheres closely; near

the cambium ring the wood exhibits numerous scattered dark groups of large porous vessels and fibres, which are seldom arranged in more than an indistinctly radiate manner, except near the crown of the root, where it passes imperceptibly into the rhizome, and one or more rings of radiate yellowish wood may be found, as well as an evident pith.

**Notes.**—In badly dried belladonna root the transverse fracture often appears brownish, hard, and resinous, and the epidermis is not easily abraded. As the alkaloids occur chiefly in the bark, old woody roots should be rejected; they may be distinguished by their prominently radiate structure. Roots collected in spring are also deficient in alkaloid; they contain sugar and but little starch, their outer surface is shrunk, and their interior is dark-coloured and spongy. Several roots may be mistaken for that of belladonna. That of elecampane contains oil glands, and the groups of vessels are inconspicuous; poke root presents a series of concentric rings; small pieces of scammony root have a very characteristic structure; marshmallow root has a fibrous bark, and radiate wood, in which scattered groups of vessels are not visible; liquorice root is yellowish internally, and possesses a characteristic sweet taste. The chief constituents of belladonna root are two alkaloids, hyoscyamine and its isomer atropine. Young roots contain hyoscyamine only, but older ones contain atropine also. In addition, belladonna root contains  $\beta$ -methyl- $\alpha$ -esculetin (scopoletin or chrysotropic acid), a fluorescent principle, whilst traces of scopolamine may be found, and belladonnine (oxyatropine) and apoatropine appear to be formed in the course of isolating the more important bases. The total alkaloid present varies, as a rule, between 0.4 and 0.6 per cent., but as much as 1.0 per cent. has been found. The plant is most active when about four years old, and wild specimens are somewhat richer in alkaloid than cultivated ones.

## Benzoinum.

**Benzoin** is a balsamic resin obtained from *Styrax Benzoin*, Dryander (N.O. Styraceæ), and probably other species of *Styrax*, though the former is the only tree definitely known to produce the resin. It is indigenous to Java and Sumatra, and yields the variety known as Sumatra benzoin. As the tree does not at any period of its development contain special secreting cells or ducts, the resin is probably a purely pathological product, the formation of which may be induced by injury to the bark of the tree, such as is caused by the benzoin collectors wounding it with an axe. The parenchymatous cells of the medullary rays appear to become resinified first, the contents and walls of the cells of the bast parenchyma and wood being attacked next. The fluid resin exudes from the incisions in the bark, or accumulates between the bark and the trunk, and gradually hardens. When quite firm the benzoin is collected and sold to Chinese traders, who soften it by the aid of heat and pack it in oblong boxes, together with a varying proportion of vegetable débris. It is exported from Padang, on the west coast of Sumatra. Siam benzoin, which is a much superior article, is collected from an unknown species of *Styrax*, growing in



the province of Luang Prabang, on the Mekong River. Preference should be given to Siam benzoin for making pharmaceutical preparations, since the Sumatra variety rarely answers the official requirements.

**Characters.**—Siam benzoin may occur in flat or curved (concavo-convex) tears, or in masses. The tears vary considerably in size, but rarely exceed 5 Cm. in length and 12 Mm. in thickness. The shape of the curved pieces is due to the resin accumulating between the bark and trunk of the tree. The tears are brittle, but soften when warmed and, when further heated, give off fumes of benzoic acid. They are opaque and milky-white internally, but are usually covered with a coating of yellowish or reddish-brown resin, which increases in thickness with age, probably as the result of chemical changes brought about by oxidation. Block Siam benzoin consists of small tears, more or less closely cemented together by a glassy reddish-brown, transparent or translucent resin, the proportion of which increases with age. Siam benzoin is characterised by its agreeable odour, recalling that of vanilla, and is almost entirely soluble in solution of potassium hydroxide, or in 5 parts of 90 per cent. alcohol, yielding only about 1 to 2.5 per cent. of insoluble residue, and not more than 1.5 per cent. of ash. Sumatra benzoin occurs only in masses, consisting of white tears imbedded in a dull reddish-brown or greyish-brown opaque resin, and having an odour recalling that of storax. It is soluble to the extent of 70 to 80 per cent. in 90 per cent. alcohol, and should not yield more than 1.5 per cent. of ash.

**Notes.**—The distinctive characters of Siam benzoin are the bold tears and vanilla-like odour; Sumatra benzoin is distinguished by the dull appearance of the resin in which the tears are imbedded, the storax-like odour, and the presence of cinnamic acid. Other varieties are the non-official Penang and Palembang benzoin, both of which are collected in the south-east districts of Sumatra. Penang benzoin also has the storax odour, and is sometimes offered as Sumatra, but it is easily distinguished by its fused and glassy appearance when fractured. Palembang benzoin is a mixture of resin and woody matter, and is probably of similar origin to Penang benzoin. The chief constituent of Siam benzoin is about 38 per cent. of benzoic acid, partly free, and the remainder combined with the two alcohols—benzo-resinol (5 per cent.) and siar-resinotannol (56 per cent.)—of which the resin mainly consists; it also contains 0.15 per cent. of vanillin, and 0.3 per cent. of an oily, aromatic liquid—probably an ester of benzoic acid. Sumatra benzoin yields about 18 per cent. of benzoic acid and 20 per cent. of cinnamic acid, both of which are partly free and partly combined with two alcohols—benzo-resinol and suma-resinotannol; it also contains about 1 per cent. of vanillin, and traces of benzaldehyde, styrol, styracin, and phenyl-propyl cinnamate, all of which tend to modify its odour. The presence of cinnamic acid is indicated by the evolution of benzaldehyde when a little powdered Sumatra benzoin is boiled in acidulated solution of potassium permanganate; Siam benzoin contains no cinnamic acid. If subjected to dry distillation, benzoin yields benzoic acid, together with various empyreumatic products, including styrol.

## Benzol.

**Benzol** is a mixture of homologous hydrocarbons obtained from light coal-tar oil. It consists chiefly of benzene,  $C_6H_6$  (about 70 per cent.), and the next higher homologue, toluene,  $C_6H_5CH_3$  (about 25 per cent.).

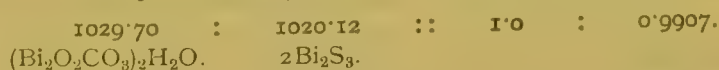
**Characters.**—Benzol is a colourless, volatile liquid, free from opalescence, with a strong characteristic odour. Specific gravity from 0.880 to 0.887. It should begin to distil at  $80^\circ C.$  ( $80.4^\circ C.$  is the boiling point of pure benzene), and about 95 per cent. of the whole should pass over at a temperature below  $79^\circ$  and  $82^\circ C.$  It should distil wholly below  $120^\circ C.$ , solidify at  $0^\circ C.$ , and not re-melt below  $4^\circ C.$

**Notes.**—Benzol must be carefully distinguished from the pure individual substance benzene. Benzol is chiefly used as a solvent, and for this purpose the presence of the toluene is no disadvantage, since toluene so closely resembles benzene in its properties. Benzol, complying with the official requirements, is known in trade as 90 per cent. benzol, because 90 per cent. distils below  $100^\circ C.$  There is also another commercial substance known as benzine or benzoline, which is obtained by fractional distillation from crude petroleum. This consists chiefly of easily volatile hydrocarbons of the paraffin series, and is therefore essentially different from benzol, which contains only hydrocarbons of the benzene series.

## Bismuthi Carbonas.

**Bismuth Oxycarbonate**,  $(Bi_2O_2CO_3)_2H_2O$ , may be obtained by adding a solution of bismuth nitrate to a solution of ammonium carbonate, collecting the precipitate, washing and drying it at a low temperature.

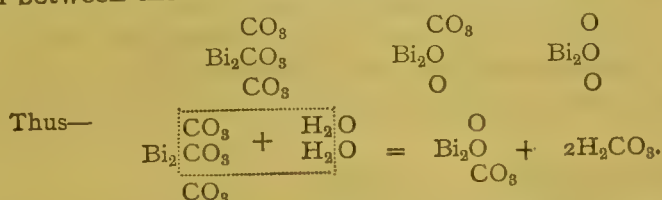
**Characters and Tests.**—Bismuth oxycarbonate is a whitish powder, the general chemical characters and reactions of which are similar to those of bismuth oxide and bismuth oxynitrate. All three compounds are heavy powders, insoluble in water, but soluble in nitric acid diluted with half its bulk of water. Each yields the reactions characteristic of bismuth. When either is dissolved in a little hydrochloric acid, the solution diluted with water slightly acidulated with the same acid, and then excess of hydrogen sulphide passed through the liquid, a brownish-black precipitate of bismuth sulphide falls. This precipitate, when rapidly washed on a counterpoised filter with water, and quickly dried at  $100^\circ C.$ , serves for the determination of the amount of bismuth present in the compound. Treated in this manner, 1 gramme of bismuth oxycarbonate should yield 0.99 gramme of bismuth sulphide:—



All bismuth salts should be free from silver, lead, copper, arsenium, iron, zinc, calcium, magnesium, selenium, tellurium, chlorides, and sulphates.

**Notes.**—The determination of bismuth as sulphide is not the most satisfactory method, because bismuth sulphide is partly oxidised during the washing and drying. The error due to that defect may be reduced by washing the precipitate with solution of sulphuretted hydrogen instead of water. A better

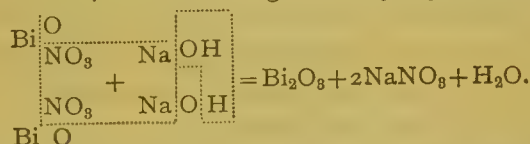
general method is to precipitate the bismuth as oxycarbonate and ignite this to oxide, which is not liable to alteration during the necessary manipulation. This method does not involve the use of counterpoised or tared filter papers. When solutions of bismuth salts are precipitated by the addition of soluble carbonates, the normal carbonate,  $\text{Bi}_2(\text{CO}_3)_3$ , is not obtained, because this decomposes immediately with formation of carbonic acid (which decomposes into water and carbonic anhydride,  $\text{CO}_2$ ) and an oxycarbonate of bismuth intermediate in composition between the oxide and normal carbonate—



[Dose.—5 to 20 grains.

## Bismuthi Oxidum.

**Bismuth Oxide**,  $\text{Bi}_2\text{O}_3$ , may be prepared by boiling bismuth oxynitrate with solution of sodium hydroxide, and washing and drying the precipitated oxide.



**Characters and Tests.**—Bismuth oxide is a slightly brownish-yellow powder. It should answer to the general characters and tests enumerated under Bismuthi Carbonas, and 1 gramme should yield 1.1 gramme of bismuth sulphide, for

$$\begin{array}{ccccccc} 462.24 & : & 510.06 & :: & 1.0 & : & 1.103 \\ \text{Bi}_2\text{O}_3 & & \text{Bi}_2\text{S}_3 & & & & \end{array}$$

**Notes.**—The hydrated bismuth oxide obtained by precipitation from an acid solution is never pure, but contains a certain proportion of the oxy-salt of the acid used. A pure bismuth oxide may be precipitated from an alkaline solution containing glycerin, by means of a dilute acid. [Dose.—5 to 20 grains.

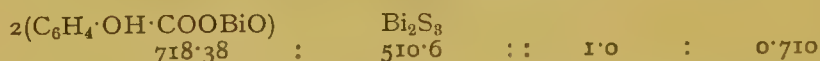
## Bismuthi Salicylas.

**Bismuth Salicylate** or **Oxysalicylate**,  $\text{C}_6\text{H}_4\cdot\text{OH}\cdot\text{COOBiO}$ , is best prepared by the action of salicylic acid on freshly precipitated bismuth hydroxide.

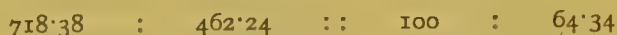
**Characters and Tests.**—Bismuth salicylate is officially described as a white, or nearly white, amorphous powder, insoluble in water, but it has recently been obtained in definite crystalline form. It affords the reactions characteristic of bismuth. Dilute solution of ferric chloride is coloured violet when bismuth salicylate is added to it, the salt being sufficiently decomposed by water, although practically insoluble, to give the characteristic colour reaction of salicylic acid. Absence of free salicylic acid cannot be shown by the official test, as the alcohol causes partial decomposition of the salt, and the liberated acid gives a violet colour with ferric chloride. If, however, benzol or chloroform be substituted for alcohol, the production of a violet colour would then



indicate that the salt had been improperly prepared, or was merely a mechanical mixture of salicylic acid with another bismuth salt. Warmed with sulphuric acid and a piece of copper foil, no red nitrous fumes should be evolved, showing that the salt contained no nitrate (probably bismuth oxynitrate). When heated with solution of sodium carbonate the salt is decomposed with formation of insoluble oxycarbonate and sodium salicylate. The filtrate will therefore give the characteristic reaction when solution of uranium nitrate is added—a yellowish-brown precipitate of uranium salicylate—provided it contains not less than 1 per cent. of sodium salicylate. This distinguishes salicylates from carbolates and sulpho-carbolates which yield a similar colour reaction with ferric chloride. One gramme of bismuth salicylate should yield 0.7 gramme  $\text{Bi}_2\text{S}_3$ , since,



When heated the salt is decomposed and, at a low red heat, leaves a residue of bismuth oxide, which amounts to between 62 and 64 per cent. of the weight of the salt ignited, for

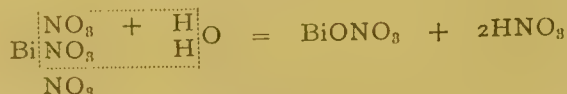


The salt should be free from the impurities mentioned under Bismuthi Carbonas.

**Notes.**—It will be noticed that the figures giving the official requirements in the two quantitative tests do not indicate an absolutely pure salt according to the formula given. The small allowances for foreign substances are probably made on account of the difficulty experienced in preparing by precipitation a pure salt, due to the fact that the precipitate cannot be very thoroughly washed, since it is gradually hydrolysed by contact with water, with formation of a more basic salt. It is, however, stated that all commercial samples contain free salicylic acid, even if prepared as officially directed. [*Dose.*—5 to 20 grains.]

## Bismuthi Subnitras.

**Bismuth Oxynitrate**,  $\text{BiONO}_3\cdot\text{H}_2\text{O}$ , is prepared by dissolving bismuth in nitric acid to form bismuth nitrate,  $\text{Bi}(\text{NO}_3)_3$ . During this reaction nitric oxide and peroxide are evolved, the exact composition of the evolved gases depending upon the concentration of the acid and the temperature at which the reaction is carried out. When the bismuth is dissolved, the solution is concentrated to expel the greater part of the excess of nitric acid, and the concentrated solution is poured into a large volume of water. The nitrate is only stable in aqueous solution when a certain quantity of free nitric acid is present, and is decomposed by the copious dilution, the oxynitrate being precipitated with liberation of some nitric acid, thus—



It must be observed that the separation of bismuth from solution, as oxysalt, is never complete, because the nitric acid formed, together with that already present in the nitrate solution, is able to retain a portion of the nitrate in solution, the proportion thus retained decreasing, however, with dilution. The

precipitated oxynitrate must be collected, washed, and dried at a low temperature. Washing with water results in the removal of more nitric acid, and production of a salt more basic than is indicated by the formula given.

**Characters and Tests.**—Bismuth oxynitrate is a heavy white, inodorous powder, consisting of minute crystalline scales with not more than a slight action on litmus. It should answer to the general characters and tests given under Bismuthi Carbonas. One gramme should yield 0·84 gramme of  $\text{Bi}_2\text{S}_3$ , for

$$\begin{array}{ccccccc} 2(\text{BiONO}_3, \text{H}_2\text{O}) & & \text{Bi}_2\text{S}_3 & & & & \\ 605\cdot25 & : & 510\cdot06 & :: & 1\cdot0 & : & 0\cdot8427 \end{array}$$

It should afford only the slightest reactions with the tests for carbonates. If 1 gramme be dissolved in just sufficient strong nitric acid, and this liquid be mixed with a solution of about 2 grammes of citric acid, and then sufficient solution of ammonia to give a decided alkalinity, no precipitate or opalescence should be produced by boiling the mixture while still faintly alkaline. This test excludes adulteration with calcium phosphate, since that substance, although soluble in the acid liquid, would be reprecipitated when the solution was rendered alkaline; the precipitation of bismuth as hydroxide, by the ammonia, is prevented by the presence of citric acid, with which bismuth forms a soluble compound (*vide* Liquor Bismuthi et Ammonii Citratis).

**Notes.**—Bismuth oxynitrate reacts slowly with water, liberating nitric acid, and forming a more basic oxynitrate. The exact course of the reaction is influenced, among other things, by the relative proportions of the reacting substances. If, for instance, the proportion of water be relatively small, the reaction proceeds until the concentration of the liberated nitric acid reaches a point beyond which the decomposition of the subnitrate cannot proceed, and a condition of equilibrium ensues. On the other hand, if the proportion of water be relatively large, the decomposition proceeds until the oxynitrate,  $\text{BiONO}_3$ , is converted into a more basic oxynitrate standing midway between the official oxynitrate and the oxide. When bismuth oxynitrate is prescribed in "mixtures" with alkaline bicarbonates, those react with the nitric acid, produced in the manner already described, and effervescence ensues, due to the evolution of carbon dioxide. Since, in this case, the nitric acid is neutralised as quickly as it is liberated, the reaction proceeds more quickly to its termination, because, with increasing concentration of nitric acid, the reaction between the oxynitrate and water proceeds with diminishing velocity, until the condition of equilibrium is attained. Hence, when an alkali is present, the retarding influence of the free nitric acid is removed, and the reaction proceeds with its initial velocity. The determination of bismuth as sulphide is more inaccurate in the case of the oxynitrate than of the other salts of bismuth, because the nitric acid present in the hydrochloric acid solution of that salt will oxidise the sulphuretted hydrogen, and the sulphur so produced will be collected and weighed with the bismuth sulphide. Analyses of commercial oxynitrate usually show a higher percentage of bismuth than corresponds with the official formula, indicating partial conversion into a more basic oxynitrate.

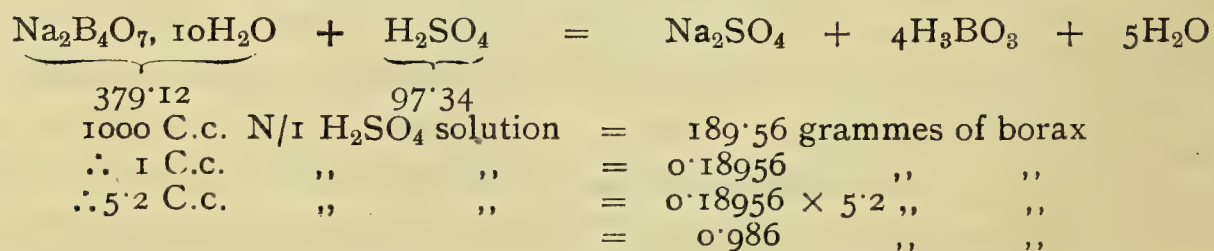
[Dose.—5 to 20 grains.]



## Borax.

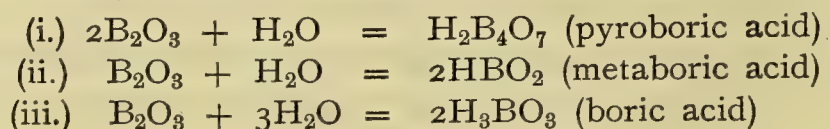
**Borax** or **Sodium Biborate**,  $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ , sometimes called sodium metaborate or pyroborate, occurs native in many parts of the world, the most important sources being California and Nevada, where it is found, mixed with earthy impurities, constituting the bed of dried-up lakes. It is also obtained from certain lakes in Thibet. The impure borax from those sources is purified by recrystallisation. The native boric acid of Tuscany also yields borax by neutralisation with sodium carbonate. Calcium and magnesium borate also occur, chiefly in Chili and Peru. Borax is obtained from those by boiling with sodium carbonate solution, which decomposes the compounds, precipitating calcium or magnesium carbonate and forming a solution from which borax can be obtained by crystallisation. The formula,  $\text{Na}_2\text{B}_4\text{O}_7$ , represents borax as the sodium salt of pyroboric acid,  $\text{H}_2\text{B}_4\text{O}_7$ , so-called because it may be obtained by heating boric acid.

**Characters and Tests.**—Borax forms transparent, colourless crystals, which are slightly efflorescent and have a weak alkaline reaction. It is insoluble in alcohol, but soluble in 25 parts of cold water, or in half its weight of boiling water. It dissolves in its own weight of glycerin, but some boric acid is liberated, and a more basic borate formed. It darkens turmeric paper like alkalies, and imparts a yellow colour to flame. A hot saturated solution, acidulated with a mineral acid, deposits a scaly crystalline precipitate of boric acid, the solution of which, in 90 per cent. alcohol, burns with a green flame. One gramme dissolved in 200 C.c. of water should require for neutralisation 5.2 C.c. of normal sulphuric acid solution, thus—

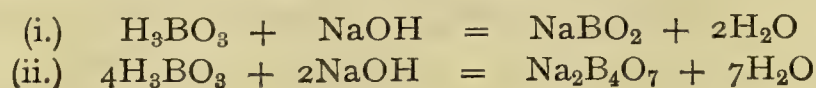


In this titration, methyl-orange is used as indicator, because boric acid, which is liberated by the reaction, has no action upon it, the red colour being only produced when the sulphuric acid is in excess of that shown in the equation. Litmus cannot be used, because boric acid slightly reddens it, and a sharp end-reaction is not obtained. Borax should be free from lead, copper, arsenium, iron, calcium, magnesium, carbonates, nitrates, and phosphates, and should contain only traces of chlorides or sulphates.

**Notes.**—Boric anhydride  $\text{B}_2\text{O}_3$  resembles phosphoric anhydride in combining with different proportions of water to form acids:—

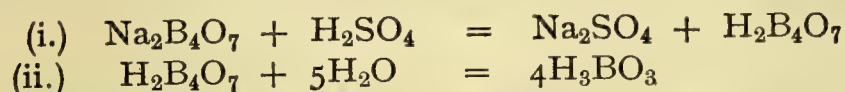


When boric acid is neutralised with an alkali the normal borate is not obtained, but water is eliminated, and a metaborate or pyroborate formed.





When solution of borax is treated with a strong acid, normal boric acid is formed, the pyroboric acid taking up water :—



The use of borax beads in qualitative analysis is due to the fused borax containing metaboric acid or anhydride. When a metallic salt is fused in a borax bead, on platinum wire, the boric anhydride, being non-volatile, displaces the acidulous radical with which the metal was combined, and forms compounds with the resulting oxide, which have a distinctive colour in the following cases:—cobalt, copper, chromium, iron, manganese, nickel, and uranium. The solvent action of fused borax upon metallic oxides explains also why it is used as a flux in soldering, since it cleans the surface of the metals to be united. [Dose.—5 to 20 grains.

## Buchu Folia.

**Buchu Leaves** are obtained from *Barosma betulina*, Bartling and Wendland (N.O. Rutaceæ), a small shrubby plant which is indigenous to Cape Colony. The leaves are collected while the plant is flowering and fruiting and then dried. They are exported from Cape Town, and are known in commerce as “short buchu.”

**Characters.**—Buchu leaves are roundish (rhomboid-obovate) in shape, from 12 to 20 Mm. long, pale green or yellowish-green in colour, rigid and brittle when dry, but cartilaginous when moist. The surface of the leaves is glabrous, finely wrinkled below, and marked with small wart-like prominences above, owing to the elevation of the epidermis by subjacent oil-glands. The margin is usually sharply denticulate, showing numerous minute sharp teeth, and the apex is blunt and recurved. On examination with a lens, by transmitted light, numerous oil-glands are distinctly visible, especially near the margin of the leaves, one being situated near the base of each indentation. A transverse section of a leaf exhibits an epidermis of five- or six-sided tabular cells, containing yellow amorphous masses or spherocrystals, said to consist of hesperidin; the thick, inner walls of those cells are rich in mucilage and swell in the presence of water. The odour of buchu, which is particularly marked when the leaves are crushed, is reminiscent of a mixture of peppermint and black currant; the strong and aromatic taste is due to the presence of a volatile oil. Ash-yield, about 4 per cent.

**Notes.**—The distinctive characters of buchu leaves from *B. betulina* are their roundish shape and recurved apex, the distribution of the oil glands, and the characteristic odour and taste. Bearberry leaves, which somewhat resemble them, are spoon-shaped, rounded at the apex, and destitute of oil-glands, while the leaves of *Empleurum serrulatum* and of other species of *Buchu* differ from those of *B. betulina* in shape, margin, distribution of oil-glands, absence of diosphenol, etc. Buchu leaves should yield from 1 to 2 per cent. of volatile oil, containing about 30 per cent. of crystalline diosphenol,  $\text{C}_{10}\text{H}_{16}\text{O}_2$ , its chief optically inactive compound; the oil also contains menthone, and a hydrocarbon with a

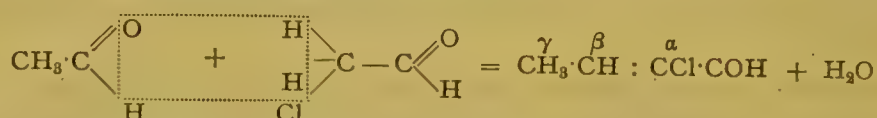
pinene-like odour. Other constituents of the leaves are diosmin, mucilage, and the yellow, physiologically inactive, crystalline substance (hesperidin) which forms the spherocrystals.

## Butyl-Chloral Hydras.

**Butyl-Chloral Hydrate**,  $\text{CH}_3\cdot\text{CHCl}\cdot\text{CCl}_2\cdot\text{CH}(\text{OH})_2$ , is a crystalline substance obtained by the addition of water to the liquid butyl-chloral produced by the action of chlorine gas on aldehyde. Chlorination of acet-aldehyde does not yield a substitution product of acet-aldehyde as the final product, owing to a condensation which occurs between two acet-aldehyde molecules, and this leads to the formation of a derivative of butyric aldehyde—a compound which contains four carbon atoms. The first product of the action of chlorine is monochlor-acet-aldehyde—



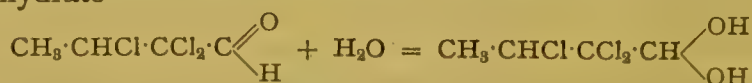
This under the influence of the hydrochloric acid condenses with another molecule of the aldehyde to form  $\alpha$ -chlor-croton-aldehyde, which is called an  $\alpha$ -compound because substitution has taken place in the group next to the aldehyde group— $\text{COH}$ . The carbon atoms are distinguished by the Greek letters  $\alpha$ ,  $\beta$ ,  $\gamma$ , etc., proceeding from the characteristic group of the compound.



The chlor-croton-aldehyde, being an unsaturated compound, takes up chlorine to form tri-chlor-butyl aldehyde or butyl-chloral—



This is a dense oily fluid which combines with water to form the crystalline butyl-chloral hydrate—



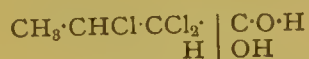
**Characters and Tests.**—Butyl-chloral hydrate occurs in pearly-white, trimetric laminæ, having a pungent, fruity, but not acrid, odour, and an acrid, nauseous taste. It melts at about  $78^\circ \text{C}$ . to a transparent liquid which, on cooling, commences to solidify at about  $71^\circ \text{C}$ . It is soluble in about 40 parts of water, in its own weight of glycerin or 90 per cent. alcohol, and slowly in 20 parts of chloroform. Its aqueous solution is neutral or but slightly acid to litmus. It does not yield chloroform when heated with solution of potassium hydroxide or milk of lime (slaked lime and water). This test detects admixture with chloral hydrate, which is hydrolysed, under the influence of the alkali, forming chloroform and formic acid when so treated, the formic acid reacting with the alkali to form alkali formate—



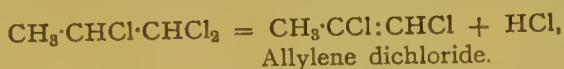
Butyl-chloral, however, yields allylene dichloride and formic acid when acted



upon by caustic potash. It first forms a tri-chloro- derivative of propane ( $C_3H_3$ ), just as chloral yields a tri-chloro- derivative of methane—



Chloroform is not further acted upon, but the tri-chloro-propane loses an atom each of chlorine and hydrogen by the action of potash, and allylene dichloride results, thus—



Allylene dichloride has an aromatic odour which somewhat resembles that of chloroform. It is, however, easily distinguished by the iso-nitrile reaction (*vide* Chloral Hydras).

**Notes.**—The solubility of butyl-chloral hydrate should be noted carefully, since a fluid ounce of water is capable of retaining barely ten grains in solution. When doses exceeding this amount are given it is desirable, therefore, to employ more than one fluid ounce of the aqueous vehicle. The reactions which occur in making this substance are interesting because they illustrate the marked tendency which aldehydes possess for polymerisation and forming condensation products. This is to be attributed mainly to the constitution of the aldehyde grouping,  $R \cdot C \cdot O \cdot H$ , which contains a doubly-linked oxygen atom and by a simple alteration in its relationship to the carbon atom enables an aldehyde to take up two other atoms or radicals—



This capacity is of the highest significance in many synthetic and metabolic processes which occur in vegetable tissues, *e.g.*, the formation of sugar. It will be noticed that butyl-chloral hydrate contains two hydroxyl groups connected with the same carbon atom. This is referred to again in connection with chloral hydrate (*vide* Chloral Hydras). Butyl-chloral hydrate was formerly, but erroneously, believed to be a tri-chloro- derivative of croton aldehyde, and was hence called croton-chloral hydrate. [Dose.—5 to 20 grains.]

## Caffeina.

**Caffeine** or **Theine**,  $C_8H_{10}N_4O_2 \cdot H_2O$ , is an alkaloid usually obtained from tea, the dried leaves of *Camellia Thea*, Link (N.O. Ternstroemiaceæ), which contain 2.5 to 4.5 per cent. It is also found in coffee, the dried seeds of *Coffea arabica*, Linné (N.O. Rubiaceæ), which contain 1 to 1.5 per cent., and in Guarana (*Paullinia Cupana*), kola nuts (*Cola acuminata*), and Paraguay tea (*Ilex paraguayensis*). When crystallised from aqueous solutions, it contains one molecule of water.

**Characters and Tests.**—Caffeine forms colourless, silky, acicular, inodorous crystals. It is soluble in 80 parts cold water, the solution having a faintly bitter taste and being neutral to litmus; easily soluble in boiling water, 90 per cent. alcohol, or chloroform; sparingly soluble in ether. It dissolves.



without colour in cold sulphuric and nitric acids, this test detecting sophistication or substitution with many other alkaloids and organic substances which give colour reactions with those reagents. At  $100^{\circ}$  C. the crystals should lose 8.5 per cent. of their weight in accordance with the proportion of water of crystallisation in the formula given above. Most samples, however, show rather less than this on drying. At a higher temperature (about  $233^{\circ}$  C.) it melts and then volatilises without decomposition. A small portion of caffeine treated with a few drops of hydrochloric acid and a minute crystal of potassium chlorate in a white porcelain dish and the mixture evaporated cautiously to dryness yields a reddish residue which becomes purple when moistened with solution of ammonia. To get satisfactory results it is best to conduct the evaporation over a water-bath, so as to avoid over-heating, and to use very little ammonia or hold the dish containing the residue over the mouth of the ammonia bottle, so that the residue is exposed to the fumes arising therefrom. This is known as the "murexide" test, and is so called because of the formation of a substance called murexin, the ammonium salt of purpuric acid. The reaction is characteristic of substances belonging to the group of uric acid derivatives. With an aqueous solution of the alkaloid, tannic acid gives a white precipitate of caffeine tannate, soluble in excess of the reagent, but no precipitate is caused by the addition of Mayer's reagent (potassio-mercuric iodide) or Wagner's reagent (iodine dissolved in solution of potassium iodide).

**Notes.**—Non-precipitation with Mayer's reagent distinguishes caffeine from all other common alkaloids, very dilute solutions of which—except morphine, with which the reaction is least delicate—give precipitates composed of double iodides of mercury and the various bases. [Dose.—1 to 5 grains.

## Caffeinæ Citras.

**Caffeine Citrate** is a weak compound, to which the formula  $C_8H_{10}N_4O_2, C_6H_8O_7$  is officially ascribed. It is best prepared by mixing caffeine, 100, with citric acid, 100, moistening the mixture with water, 16, and drying on a water-bath. The proportions of the two constituents employed correspond approximately to the formula given above ( $C_8H_{10}N_4O_2, H_2O = 210.68$  and  $H_8C_6H_5O_7, H_2O = 208.50$ ).

**Characters and Tests.**—Caffeine citrate is a white, inodorous powder, with an acid and faintly bitter taste, and an acid reaction on litmus. The fact that the substance tastes both acid and bitter indicates that the moisture of the mouth is sufficient to dissociate it partially into its constituents. It is soluble in 32 parts of water, and since it only contains half its weight of caffeine (soluble 1 in 80 of water), dissociation by that proportion of water is almost complete. The citrate is also soluble in a mixture of 2 parts of chloroform and 1 part of 90 per cent. alcohol. With 3 parts of water it forms a clear, syrupy solution, but more water dissociates the salt and affords a white precipitate of caffeine, which redissolves when more water is added. Heated in the air the salt is charred and

then burnt, leaving a mere trace of ash. It affords the reactions characteristic of caffeine and of citrates.

**Notes.**—When properly prepared caffeine citrate yields no caffeine to chloroform, showing that a compound is really formed, although one that is readily dissociated in aqueous solution. The citric acid in caffeine citrate may be titrated with standard alkali, using phenol-phthalein, as indicator. Caffeine is such a weak base that it does not interfere with the indication.

[Dose.—2 to 10 grains.

## Caffeinæ Citras Effervescens.

**Effervescent Caffeine Citrate** is made by granulating a mixture of caffeine citrate, tartaric and citric acids, sodium bicarbonate, and sugar. On the small scale granulation is best effected by heating the mixed powders on a flat dish or plate set over a saucepan of boiling water, so as to avoid the risk of overheating with a naked flame or sandbath. If the dish projects well over the edge of the saucepan and the water be not boiled too fast, the risk of steam coming in contact with the granulating mixture is also avoided, the object being to produce the granules with as little reaction as possible between the acids and the bicarbonate. The official preparation contains 4 per cent. of caffeine citrate, so that a heaped teaspoonful of the granules contains about 2 grains of caffeine citrate.

[Dose.—60 to 120 grains.

## Calcii Carbonas Præcipitatus.

**Precipitated Calcium Carbonate**, known commonly as precipitated chalk, is produced by mixing solutions of calcium chloride and sodium carbonate, boiling the mixture, then collecting, washing, and drying the precipitate of calcium carbonate.



**Characters and Tests.**—Precipitated calcium carbonate is a white micro-crystalline powder insoluble in water. It affords the reactions characteristic of calcium and of carbonates. It should be free from iron, aluminium, phosphates, or sulphates, and yield only the slightest reactions with the tests for magnesium and chlorides.

**Notes.**—Calcium carbonate is insoluble in pure water, but if the water contains dissolved carbon dioxide, *i.e.*, carbonic acid, it is capable of dissolving calcium carbonate, a soluble bicarbonate being probably formed. This soluble calcium compound is, however, decomposed when the solution is boiled, carbon dioxide being expelled and the carbonate deposited as a crust or film on the sides of the vessel in which the boiling is conducted. This is the cause of "furring" in kettles and boilers, because spring water always contains carbonic acid which has dissolved some calcium carbonate in its passage through the soil.

[Dose.—10 to 60 grains.

## Calcii Chloridum.

**Calcium Chloride**,  $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ , is produced by neutralising hydrochloric acid with calcium carbonate, evaporating the filtered liquid, and drying the residue at a temperature not exceeding  $200^\circ \text{C}$ .



When dried at higher temperatures, the salt reacts with the water present, with evolution of hydrochloric acid and production of some oxide or oxychloride. Samples which have been overheated are, therefore, alkaline and not easily or entirely soluble in water. The anhydrous salt is better for medicinal use.

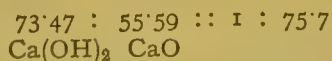
**Characters and Tests.**—Calcium chloride occurs in dry, white, deliquescent masses, soluble in an equal weight of water and in 3 parts of 90 per cent. alcohol. It affords the reactions characteristic of calcium and of chlorides. It should be free from arsenium, iron, aluminium, or carbonates, and contain only traces of magnesium. It evolves no chlorine or hypochlorous acid on the addition of hydrochloric acid, this test distinguishing it from bleaching powder, which is commonly known and sold as “chloride of lime.”

**Notes.**—Calcium chloride, on account of the avidity with which it abstracts moisture from the air, is used as a drying agent in desiccators and in tubes of a special form, which are used to absorb the water produced in the combustion of organic substances during the operation of ultimate analysis. It is a very common by-product in chemical operations. [*Dose.*—5 to 15 grains.]

## Calcii Hydras.

**Calcium Hydroxide**, commonly known as slaked lime, is prepared by adding water to calcium oxide (quick-lime). This operation, which is known as “slaking,” is accompanied by the evolution of much heat.

**Characters and Tests.**—Calcium hydroxide affords the reactions characteristic of calcium and is slightly soluble in water, forming an alkaline solution. When strongly heated, water is expelled, and a residue of calcium oxide is left, weighing rather more than three-fourths of the weight of the original hydroxide, for—



It should contain only traces of iron, aluminium, magnesium, sodium, potassium, carbonates, phosphates, sulphates, or silica.

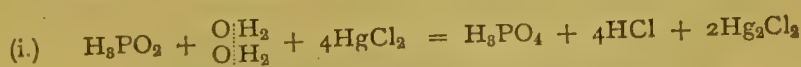
**Notes.**—Calcium hydroxide is only slightly soluble in water. In many reactions a mixture of slaked lime and water rubbed together to the consistence of thin cream is employed under the name of “milk of lime” (*vide* tests for Butyl-Chloral Hydras). Slaked lime may be partially purified by sifting, which will separate flinty impurities, while washing with a limited quantity of water removes many impurities which are easily soluble. It readily absorbs carbon dioxide when exposed to air, forming calcium carbonate; hence it should be preserved in well closed vessels.



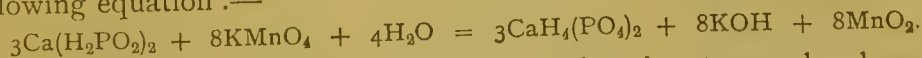
## Calcii Hypophosphis.

**Calcium Hypophosphite**,  $\text{Ca}(\text{PH}_2\text{O}_2)_2$ , is obtained by boiling phosphorus with calcium hydroxide and water. Hydrogen phosphide is evolved, and the filtrate, after precipitating any dissolved calcium hydroxide as carbonate, by passing carbon dioxide through the solution, is evaporated carefully to dryness, or evaporated to a low bulk, and precipitated by the addition of alcohol, in which calcium hypophosphite is insoluble.

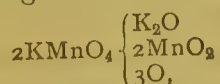
**Characters and Tests.**—Calcium hypophosphite is a white crystalline salt, with a pearly lustre and a bitter nauseous taste. It is soluble in 8 parts (or rather less when quite pure) of cold water, but insoluble in cold 90 per cent. alcohol: this distinguishes it from sodium hypophosphite, which is freely soluble in alcohol. Heated to redness, the crystals ignite, evolving inflammable hydrogen phosphide and hydrogen, and leaving a reddish coloured residue. This consists chiefly of calcium pyro- and metaphosphates, produced by the oxidation of part of the hypophosphite at the expense of another part, the phosphorus of which is reduced to hydrogen phosphide. An aqueous solution yields with solution of mercuric chloride a white precipitate of mercurous chloride, which is further reduced to a grey precipitate of metallic mercury if sufficient hypophosphite be present. The reduction of the mercuric salt is accompanied by a corresponding oxidation of the hypophosphite to phosphate, water taking part in the reaction. Using the formula for the free acid, for the sake of simplicity, the reaction may be represented in two stages:—



If 0.25 gramme be boiled for ten minutes with a solution of 0.6 gramme of potassium permanganate, it should yield on filtration a nearly colourless solution. This test depends upon the oxidation of the hypophosphite to phosphate, the permanganate being reduced, and since this oxidation is carried out in a neutral solution, the permanganate is reduced to manganese dioxide, which is thrown out as a brown precipitate (the reduction follows another course in an acid solution—*vide* Potassii Permanganas). If, therefore, the hypophosphite be pure the pink solution will be decolorised. The calculation is based upon the following equation:—



This equation may be better understood by noting that two molecules of permanganate are capable of yielding three atoms of oxygen—

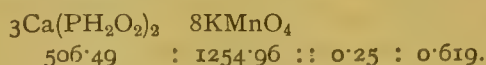


while each molecule of calcium hypophosphite requires four atoms of oxygen to convert it into phosphate—



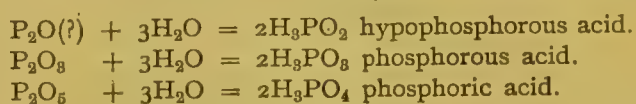
Therefore, three molecules of the calcium salt will require eight molecules of

permanganate, this being the simplest possible proportion. The acid calcium phosphate and the potassium hydroxide will, of course, react to produce an insoluble calcium phosphate (which is precipitated with the manganese dioxide) and potassium phosphate. On the basis of the equation considered, 0.25 gramme of pure anhydrous calcium hypophosphite should decolorise 0.619 gramme of potassium permanganate. For—

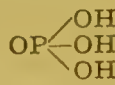
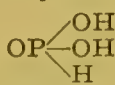
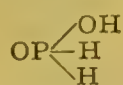


The official test allows for a slight deficiency. Moreover, it includes phosphite, since that also will reduce permanganate, so that, although a simple test, it is somewhat rough and, if the salt be deficient, it yields no indication of the extent of the deficiency. Calcium hypophosphite should be free from lead, copper, arsenium, iron, aluminium, magnesium, sodium, or potassium, and contain only traces of chlorides and sulphates. Its solution should afford little or no precipitate with solution of lead acetate, which will detect contamination with phosphate or phosphite, since lead phosphate and phosphite are insoluble in water, while lead hypophosphite is soluble. Commercial samples are said to contain more or less calcium phosphite, which is always produced during manufacture by secondary reactions, and is difficult to separate on the manufacturing scale without considerably increasing the cost of production. Papers relating to the assay of hypophosphite in the *Pharmaceutical Journal*, [4], 5, 150, and 7, 173, should be consulted.

**Notes.**—The anhydride corresponding to hypophosphorous acid, which would have the formula  $\text{P}_2\text{O}$ , has not been obtained in the free state. Compare this acid with those derived from the two higher oxides,  $\text{P}_2\text{O}_3$  and  $\text{P}_2\text{O}_5$ .



Although according to these formulæ each acid contains three atoms of hydrogen, the first is monobasic, the second dibasic, and the third tribasic, *i.e.*, one, two, and three atoms of hydrogen respectively are replaceable by metals to form salts. For this reason the formulæ for the first two are often written  $\text{HPH}_2\text{O}_2$  and  $\text{H}_2\text{PHO}_3$  to indicate this difference in behaviour of the hydrogen atoms. An explanation is furnished by the usually accepted constitutional formulæ for those acids—



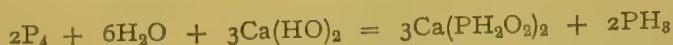
Hypophosphorous Acid.

Phosphorous Acid.

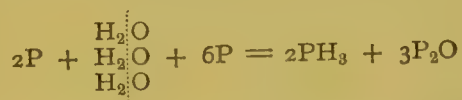
Phosphoric Acid.

in which it is seen that the number of hydroxyl (OH) hydrogen atoms corresponds to the number of atoms replaceable. These formulæ also help to explain the behaviour of the three acids to nascent hydrogen—the first two yield  $\text{PH}_3$ , whilst phosphoric does not. The formation of  $\text{PH}_3$  is probably determined by the direct connection of hydrogen to phosphorus, the three atoms of hydrogen in phosphoric acid being connected with oxygen. Compare the behaviour of sulphurous acid  $\text{O}_2\text{S} \begin{array}{l} \text{OH} \\ \text{H} \end{array}$  and sulphuric acid  $\text{O}_2\text{S} \begin{array}{l} \text{OH} \\ \text{OH} \end{array}$  towards nascent hydrogen. The formation of calcium hypophosphite by the official

process is attended by the evolution of phosphoretted hydrogen, which is never pure, as several secondary reactions take place. The equation usually given for this reaction—



is simplified by the hypothetical interpretation that phosphorus is oxidised to  $P_2O_3$ ,  $PH_3$  being formed in equivalent quantity by reaction with water—



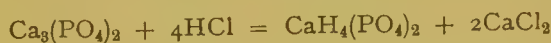
The  $3P_2O$  unites with water to form hypophosphorous acid,



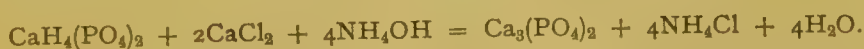
and the acid is neutralised by the calcium hydroxide, with formation of calcium hypophosphite. [Dose.—3 to 16 grains.]

## Calcii Phosphas.

**Calcium Phosphate**, according to the official description, may be either normal tri-calcium orthophosphate,  $Ca_3(PO_4)_2$ , or calcium hydrogen orthophosphate,  $CaHPO_4, 2H_2O$ . Bone-ash consists chiefly of the calcium phosphate,  $Ca_3(PO_4)_2$ , with calcium carbonate and fluoride. When treated with hydrochloric acid it almost entirely dissolves, the normal calcium phosphate being converted into a soluble acid phosphate known as superphosphate—



while the carbonate dissolves with evolution of carbon dioxide, forming more calcium chloride. The filtrate, containing the calcium acid phosphate and chloride, throws down a voluminous precipitate of the original calcium phosphate when rendered alkaline with ammonia—



When solutions of calcium chloride and sodium phosphate (di-sodium hydrogen phosphate) are mixed, a precipitate of calcium hydrogen phosphate is obtained, corresponding in constitution to the sodium salt—



This variety of calcium phosphate is precipitated with two molecules of water,  $CaHPO_4, 2H_2O$ ; when strongly heated it loses about 25 per cent. of its weight and is converted in calcium pyrophosphate—



**Characters and Tests.**—Calcium phosphate is a light white amorphous powder, insoluble in water, but soluble in diluted hydrochloric acid and diluted nitric acid. Those acid solutions remain clear when an excess of a dilute solution of sodium acetate is added, while if calcium oxalate be present, it will be precipitated. This depends upon the fact that calcium oxalate is soluble, like the phosphate, in the dilute mineral acids, but insoluble in acetic acid, which



replaces the hydrochloric or nitric acids when an excess of sodium acetate is added to its solution in mineral acids—



One gramme of the recently dried powder, dissolved in diluted hydrochloric acid, when added to a very slight excess of diluted solution of ammonia, yields a white precipitate of calcium phosphate, weighing, when washed with cold water and dried at 100° C., not less than 0.95 gramme. It should yield the reactions characteristic of phosphates and of calcium, and be free from lead, copper, arsenium, iron, aluminium, magnesium, carbonates, or silica, while containing only traces of chlorides.

[Dose.—5 to 15 grains.

## Calumbæ Radix.

**Calumba Root** is obtained from *Jateorhiza Columba*, Miers (N.O. Menispermaceæ), a lofty, climbing plant, indigenous to Portuguese East Africa, which produces swollen fleshy roots. Those are dug up in the dry season, cut into transverse slices and dried.

**Characters.**—Calumba root occurs in irregular, flattish, circular, or somewhat oval slices, which are usually from about 2.5 to 5 Cm. in diameter and from 3 to 12 Mm. in thickness, though both larger and thicker pieces may be found. They are more or less uniformly yellow in colour, break with a short starchy fracture, have a feeble, musty odour, and a marked bitter taste, due to the bitter principles the drug contains. If the dull greyish or greenish-yellow surface be shaved off with a knife the colour will be found to be much brighter inside, and the yellow tint most marked near the cork and the cambium. The circumference of the sections consists of a thin, dark-brown, wrinkled, corky layer; the cork is easily separated from the yellowish-brown bark which occupies about one-fifth of the diameter of the root; the bark is marked with radiating lines of sieve tissue, and is divided from the central woody portion by the dark cambium line. The wood is of a lighter colour than the bark, and contains vessels arranged in narrow, radially-elongated groups. The parenchymatous tissue is largely developed, and contains numerous starch-grains, both in the wood and bark; the starch-grains are mostly simple, with an eccentric or non-central hilum. The slices are usually somewhat shrunken and depressed in the centre, the greater contraction there on drying being probably due to the central tissue being less woody and less loaded with starch than the outer portions. The drug yields from 4 to 8 per cent. of ash.

**Notes.**—Slices of the stem of *Coscinium fenestratum* are distinguished from calumba by being dark yellow in colour, hard and woody, free from starch, and not depressed in the centre; slices of the root of *Frasera caroliniensis* contain tannin, and are usually smaller and thicker than those of calumba, besides being free from starch. Calumba root contains three yellow crystalline alkaloids—jateorhizine, columbamine, and palmatine—all of which are closely related to corydaline and berberine; the drug also contains two colourless, crystalline, bitter principles, one of which (columbin) appears to be a lactone, and yields yellow, amorphous columbic acid when treated with acid or alkali. Much starch is also present, together with some mucilage and a fluorescent body, but tannin is absent.

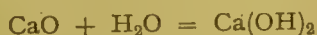
## Calx.

**Lime or Calcium Oxide**,  $\text{CaO}$ , is obtained by calcining chalk, limestone, or marble. Those three substances are forms of native calcium carbonate, which, when strongly heated, lose carbon dioxide and leave a residue of calcium oxide, thus—



Marble, being the purest of the three forms of carbonate, naturally yields the purest lime.

**Characters and Tests.**—Calcium oxide occurs in compact masses of a whitish colour, which readily absorb water; when rather less than their weight of water is added, they swell and fall to powder, with the development of much heat and formation of calcium hydroxide—



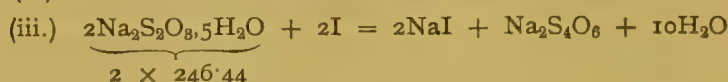
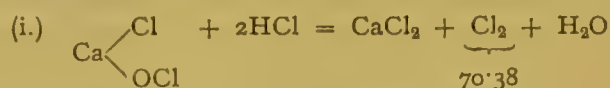
The powder obtained by this process of slaking, when agitated with water, gives, after filtration, a clear alkaline solution which affords the reaction characteristic of calcium. It should contain only traces of iron, aluminium, magnesium, sodium, potassium, carbonates, chlorides, phosphates, sulphates, or silica.

## Calx Chlorinata.

**Chlorinated Lime** is obtained by exposing slaked lime to the action of chlorine gas until absorption ceases. The product is popularly known as “Chloride of Lime.” It is a mixture or a weak compound of hypochlorite and chloride of calcium with slaked lime, the latter never being, in practice, wholly converted into the chlorinated compound by the action of chlorine. The formula  $\text{Ca}_2\text{ClO}$ ,  $\text{CaCl}_2$ , or  $\text{CaOCl}_2$ , would yield 55.9 per cent. of chlorine by the action of acids; the official requirements are satisfied by a product yielding 33 per cent. of chlorine—the term “available chlorine” refers to the amount of chlorine evolved by the action of acids.

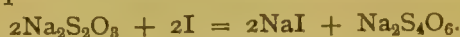
**Characters and Tests.**—Chlorinated lime is a dull white powder with a characteristic smell; it becomes moist and gradually decomposes on exposure to air, owing chiefly to the action of carbon dioxide, which slowly liberates chlorine and leaves a residue consisting chiefly of calcium carbonate and chloride. If kept in dry air the decomposition occurs much more slowly, because the carbon dioxide in the air is then unable to attack it. The compound is partially soluble in water; if relatively little water be used a preponderating quantity of calcium chloride is extracted, but with more water the solution appears to contain chloride and hypochlorite, the residue consisting chiefly of calcium hydroxide. The solution affords the reactions characteristic of calcium and chlorides, and decolorises solution of indigo sulphate, this effect being due to the formation of a colourless indigo derivative by the oxidising action of the chlorine which is set free by the acid in the indigo solution. It evolves chlorine copiously on the addition of an acid; 0.5 gramme of chlorinated lime, mixed with 1.5 gramme of potassium iodide dissolved in 200 C.c. of

water, produces, when acidulated with 6 C.c. of hydrochloric acid, a reddish solution, which requires for the discharge of its colour at least 46·8 C.c. of decinormal sodium thiosulphate solution, corresponding to 33 per cent. of available chlorine, thus—

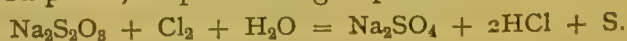


$$\begin{aligned} 1000 \text{ C.c. of N/10 sodium thiosulphate sol.} &= \frac{70\cdot38}{20} && \text{grammes chlorine} \\ \therefore 1 \text{ C.c.} &= \frac{70\cdot38}{20 \times 1000} && \text{" "} \\ &= 0\cdot003519 && \text{" "} \\ \therefore 46\cdot8 \text{ C.c.} &= 0\cdot003519 \times 46\cdot8 && \text{" "} \\ &= 0\cdot165 && \text{" "} \end{aligned}$$

This determination of the chlorine is therefore indirect, *i.e.*, it is liberated in the presence of potassium iodide, and the equivalent quantity of iodine ( $\text{Cl}, 35\cdot19 = \text{I}, 125\cdot90$ ) displaced by the chlorine is determined by titration with sodium thiosulphate solution. This is the most convenient way of determining free chlorine, the end reaction between iodine and sodium thiosulphate (disappearance of the brown colour of free iodine, or blue colour, if starch be employed) being sharply distinguished. In iodine titrations it is advisable not to add starch mucilage until nearly all the iodine has been used up, *i.e.*, when the brown colour has almost disappeared. If the starch be added at first when much of the iodine is free, a blackish colour is produced and the end reaction is not so sharp. Some operators do not use starch at all, but, used as described above, the termination of the reaction is more apparent, since the blue colour of iodide of starch is more intense than the brown colour of an equivalent quantity of iodine. It should be noted that the action of chlorine (and bromine) upon sodium thiosulphate is quite different from that of iodine—



In presence of water, chlorine is an energetic oxidising agent, and converts the thiosulphate into sulphate, sulphur being deposited—



Hence the determination of chlorine by thiosulphate cannot be made directly.

## Calx Sulphurata.

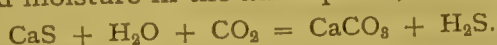
**Sulphurated Lime** is a mixture containing not much less than fifty per cent. of calcium sulphide,  $\text{CaS}$ , with calcium sulphate and carbon. It may be prepared by heating an intimate mixture of calcium sulphate and wood charcoal (carbon) in a covered crucible, the carbon reducing the sulphate to sulphide



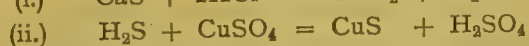
**Characters and Tests.**—Sulphurated lime is a greyish-white powder, with an odour of hydrogen sulphide. Since calcium sulphide is not volatile this



odour must be due to slow decomposition of the sulphide under the influence of the carbon dioxide and moisture in the atmosphere, thus—



If 0.8 gramme be mixed with a cold solution of 1.4 gramme of copper sulphate in 50 C.c. of water, and, after the addition of a little hydrochloric acid, the mixture be well stirred and heated to a temperature approaching that of ebullition until all action has ceased, and then filtered, the filtrate should give no red colour with solution of potassium ferrocyanide. This test is intended to show that the preparation contains the required proportion of calcium sulphide and depends upon the liberation of hydrogen sulphide with precipitation of copper sulphide. If the sample contains half its weight of CaS, then the whole of the copper will be precipitated as copper sulphide, and the filtrate will yield no red colour or precipitate with potassium ferrocyanide. The latter compound is a very delicate reagent for the detection of copper, because copper ferrocyanide is a deep red, insoluble compound. In extremely dilute solutions a precipitate is not immediately formed, but the presence of copper is revealed by the formation of a red colour. Representing the reaction in two stages—



it will be seen that one molecular weight of copper sulphate ( $\text{CuSO}_4, 5\text{H}_2\text{O} = 247.86$ ) is precipitated as sulphide by one molecular weight of calcium sulphide ( $\text{CaS} = 71.53$ ) and therefore 1.4 gramme of  $\text{CuSO}_4, 5\text{H}_2\text{O}$ —the quantity in the official test—will indicate 0.40 gramme CaS in the 0.8 gramme of sulphurated lime taken for analysis, equivalent to 50 per cent.; for

$$247.86 : 71.53 :: 1.4 : 0.40.$$

**Notes.**—It does not seem practicable to produce by the official process a sample of pure calcium sulphide, and commercial samples of sulphurated lime hardly ever attain the official standard. Sulphurated lime should be preserved in well stoppered bottles. It is usually given in the form of pills, which should be varnished in order to preserve the material from the action of the air and to minimise the unpleasant sulphuretted odour given off. [*Dose.*— $\frac{1}{4}$  to 1 grain.]

## Cambogia.

**Gamboge** is a gum-resin, obtained from *Garcinia Hanburii*, Hooker filius (N.O. Guttiferæ), a tree which grows in Siam, near the south-west coast of Cambodia, and on some of the adjacent islands, as well as in the southern parts of Cochin China. The gum-resin occurs as a yellow, opaque juice in secretory ducts found in the cortex of the tree and in the bast, the two systems of tissue being connected by transverse canals at the nodes. The juice issues in drops on breaking off the leaves and shoots of the tree, or, during the rainy season, spiral cuts are made in the bark in a longitudinal direction, to a height of about 3 metres above the ground, and the yellow juice as it exudes is received in hollow bamboos, from which it is transferred to smaller ones, in which it is allowed to solidify, any water present being driven off by mild continuous heat. After the lapse of a month, the solidified

gamboge is removed from the bamboos by heating the latter over a fire until they crack and peel off. The pipes or cylinders of gum-resin, which are often more or less hollow owing to contraction during drying, are allowed to harden before being packed for exportation from Bangkok. Sometimes the pipes are agglutinated into masses, in which traces of the pipe formation are still evident. Another variety of the gum-resin, known as cake or lump gamboge, is exported from Saigon in cakes or masses which bear the impression of leaves in which they have been wrapped. Pipe gamboge is the best, and that alone is official.

**Characters.**—Gamboge should be in cylindrical solid or hollow rolls or pipes, from about 2.5 to 5 Cm. in thickness, and from 10 to 20 Cm. in length, the pipes being marked with longitudinal furrows caused by ridges on the inner surface of the bamboos in which they have been dried, and either separate or agglutinated into masses which reveal traces of the pipe formation. The pipes show a smooth, uniform, conchoidal or shell-like fracture when broken, the freshly broken surface having a dull gloss, and being of a uniform reddish-yellow or brownish-orange colour. The drug is easily reduced to a bright yellow powder and possesses little or no odour, but has a very acrid taste, due to the resin it contains. When rubbed with water, a yellow emulsion is formed, the gum dissolving, and the resulting mucilage holding the resin and other constituents of the drug in suspension. The resin is soluble in alkaline solutions, whilst by successive treatment with 90 per cent. alcohol and water, gamboge should be completely dissolved. Powdered gamboge should be free from added starch, the presence of that substance as an adulterant being indicated by making a decoction with boiling water, allowing it to cool, and adding solution of iodine; if more than traces of starch be present, the cooled decoction turns green, the blue of the compound of starch and iodine blending with the yellow of the decoction. When incinerated, gamboge should not yield more than 3 per cent. of ash.

**Notes.**—Cake gamboge occurs in irregular masses of 1 to 1.5 kilogrammes or more, the masses often containing sticks and other impurities; they also contain many air cells, and are less dense, less uniform in texture, and less brittle than pipe gamboge. Inferior gamboge, whether pipe or cake, is of a dark brownish colour, and breaks with a dull, rough, splintery fracture, the fractured surface often exhibiting small cavities. Gamboge of good quality contains from 70 to 80 per cent. of resin (cambogic acid), 15 to 25 per cent. of gum analogous to acacia, about 2.5 per cent. of moisture, and traces of starch. The chief adulterants of gamboge are starch, sand, vegetable debris, etc., all of which are insoluble in alcohol or water (used successively), or in dilute ammonia. More than traces of starch can be detected by the iodine test; inorganic substances, if present, will increase the percentage of ash left upon incineration.

[Dose.— $\frac{1}{2}$  to 2 grains.

## Camphora.

**Camphor** is a white crystalline substance obtained from *Cinnamomum Camphora*, Nees and Ebermaier (N.O. Laurineæ), a large tree which grows in



Formosa and Japan, whence the drug is exported to Europe. All parts of the tree contain a volatile oil, one of the constituents of which is camphor, but the drug is obtained almost exclusively from the wood. After the tree has been felled the wood is reduced to chips, and heated with water in a rude still. The camphor is carried over with the water-vapour, and sublimes in an earthenware dome. The crude mass thus obtained is largely exported in tubs to London or Hamburg and there purified by re-sublimation, but much purified camphor is also exported from Formosa.

**Characters.**—Camphor occurs in three forms—in solid, colourless, transparent, crystalline pieces or “bells” of tough consistence; in rectangular masses; and in pulverulent masses, known as “flowers of camphor.” Its specific gravity is about 0.995, but tends to vary from 0.986 to 0.996. The powerful, penetrating odour of camphor is characteristic, and its pungent, bitterish taste is followed by a sensation of cold. It burns readily with a bright, smoky flame, volatilises at ordinary temperatures, and sublimes when heated, without leaving any residue. One part of camphor dissolves in about 700 parts of water, in 1 part by weight of 90 per cent. alcohol, or in 4 parts of olive oil; chloroform dissolves 4 times its weight and ether 12 parts in 7. On triturating camphor with an equal weight of chloral hydrate or with one-third its weight of carbolic acid in crystals an oily liquid is formed; a similar result is attained by triturating it with menthol or thymol.

**Notes.**—The composition of camphor corresponds to the formula  $C_{10}H_{16}O$ , and the substance should probably be regarded as a ketone or a keto-tetrahydrocymene, its behaviour with hydroxylamine being in accordance with that view. It may be prepared artificially by oxidising camphene—a solid terpene ( $C_{10}H_{16}$ )—by chromic acid mixture, and upon reduction is converted into the alcohol borneol,  $C_{10}H_{18}O$ . Crude camphor is mixed with a yellowish oil, known as camphor oil, which is an exceedingly complex mixture of hydrocarbons and oxygenated substances, including acetaldehyde, camphor, terpeneol, eugenol, safrol, cineol, pinene, phellandrene, dipentene, and cadinene. Light camphor oil (specific gravity 0.89 to 0.92) consists of the low boiling fractions, and is used for perfuming ordinary soaps, or as a substitute for turpentine as a solvent for resins, etc. Heavy camphor oil (specific gravity 0.96 to 1.020) boils between  $240^{\circ}$  and  $270^{\circ}$ ; it is chiefly valuable as a source of safrol, which is used in large quantities in the preparation of synthetic heliotropin. The heavy oil deprived of its safrol and having the specific gravity 0.96 to 0.995 is added to cheap soaps and lubricants. The relative proportions of camphor and camphor oil in crude camphor vary considerably, and it should be noted that camphor which is distinctly oily or excessively brittle does not meet the official requirements.

[Dose.—2 to 5 grains.

## Cannabis Indica.

**Indian Hemp** is derived from *Cannabis sativa*, Linné (N.O. Urticaceæ), an annual, dioecious herb, indigenous to Central and Western Asia, and largely cultivated in temperate climates for the sake of its strong fibres (hemp) and oily seeds. The source of the drug, however, is the female plant grown in India, as that alone secretes any quantity of the resin to which the medicinal properties



are due. The pistillate or female plants, therefore, having been pruned to produce flowering branches, have their flowering or fruiting tops collected, and—without removal of the resin—pressed into the more or less compact masses known commercially as “ganja,” “gunjah” or “guaza.” The drug should be completely dried and kept in air-tight containers. The larger leaves of the Indian hemp plant, collected separately and dried, are known as “bhang.”

**Characters.**—*Cannabis indica* occurs in compressed, rough, flattened masses of a dusky-green colour, consisting of the branched upper part of the stem of the plant, from 5 to 30 Cm. long, bearing leaves and pistillate flowers or fruits, which are matted together by a resinous secretion. The straight stem has ascending branches, is longitudinally furrowed, and bears numerous small, one-celled, curved, appressed hairs and occasional stalked glands. The upper and more important leaves are simple, alternate, and 1 to 3 partite; the lower leaves are opposite, digitate, and consist of five to seven linear-lanceolate leaflets with distantly serrate margins. The pistillate flowers are small, the single ovary in each being surrounded by a perianth and supported by a bract, beyond which protrude two long brown stigmas. The fruit is ovoid, slightly reticulated, contains a single oily seed, and is supported by an ovate-lanceolate bract. Both leaves and bracts bear numerous hairs and glands, like those on the stem. The hairs are enlarged at the base, and contain cystoliths; the glands secrete a viscid adhesive resin. The drug has a powerful odour and is almost devoid of taste. Ash-yield, about 15 per cent.

**Notes.**—The distinctive characters of Indian hemp are the rough, dusky-green masses in which the drug occurs, the curved appressed hairs, and the linear-lanceolate leaflets on the lower leaves. The chief constituents of the drug are about 15 to 20 per cent. of a soft, brown, amorphous resin, named cannabin or cannabinone, and a little volatile oil, which consists principally of a sesquiterpene (cannabene) and a stearoptene. The resin is freely soluble in 90 per cent. alcohol or in ether, and by oxidation with nitric acid is converted into a white, crystalline substance, named oxycannabin. Other constituents of the drug are fat, wax, an inactive resin-acid, and choline or bilineurine. When collected from the fresh plant and allowed to consolidate into an oily, resinous mass, the secretion of Indian hemp constitutes the drug known as “charas” or “churrus”; this, when distilled under reduced pressure, yields a terpene (boiling point  $150^{\circ}$  to  $180^{\circ}$  C.), a sesquiterpene (boiling point  $258^{\circ}$  to  $259^{\circ}$  C.), a crystalline paraffin (melting point  $63.5^{\circ}$  C.), and a red oil named cannabinol (cannabindon), which sets to a viscid, semi-solid, odourless mass, and appears to constitute the intoxicating principle of Indian hemp, and of the resin referred to above. No peculiar alkaloid has been found in Indian hemp; the supposed alkaloid “tetano-cannabine,” is probably choline, and the substance to which the name “cannabinine” has been applied is said to be trimethylamine, produced by the action of alkalies upon choline.

## Cantharis.

**Cantharides** consists of the dried beetle, *Cantharis vesicatoria*, Latreille (Order Coleoptera), which is widely distributed over Southern Europe, and collected in Spain, France, Russia, Sicily, and Hungary. The insects are

gregarious and are collected by shaking them from the trees—ash, privet, elder, etc.—which they frequent, the time selected being before sunrise, whilst they are unable to use their wings. After being shaken on to cloths the beetles are killed by the aid of heat, or by exposing them to the fumes of ammonia or of burning sulphur.

**Characters.**—Cantharides are from 18 to 25 Mm. long, about 6 Mm. broad, and have a strong, disagreeable odour which diminishes on keeping. They have two long, narrow elytra or wing-sheaths of a shining green or coppery-green colour, under which are concealed two thin brownish transparent membranous wings.

**Notes.**—The rose beetle—*Cetonia aurata*, Linné—is similar in colour to cantharides, but broader; Chinese blistering beetles—*Mylabris* sp.—are shorter, and their wing cases are marked with transverse black and yellow bands. Cantharides contain from 0.5 to 1 per cent. of cantharidin, about 12 per cent. of fixed oil, a volatile principle to which the fetid odour of the insects is due, acetic acid, phosphates, and inert extractive matter. Cantharidin, to which the vesicant properties of the beetles are due, is a crystalline substance,  $C_{10}H_{12}O_4$ , which takes up a molecule of water, under the influence of alkalies, and is converted into salts of cantharidic acid,  $C_{10}H_{14}O_5$ , cantharidin being re-precipitated from the solutions; and water liberated on the addition of acids. It would thus appear that cantharidin is a lactone of cantharidic acid. Cantharidin is insoluble in water, though its potassium and sodium compounds are soluble, and it is only sparingly soluble in alcohol, but it dissolves readily in acetic ether or in chloroform. It exists chiefly in the soft parts of the insect, partly in the free state and partly in the form of compounds soluble in water. Cantharides are sometimes adulterated with whole beetles which have been treated with a solvent to extract the cantharidin.

## Caoutchouc.

**India-rubber** is the product of *Hevea brasiliensis*, Mueller Arg. (N.O. Euphorbiacæ), and other species indigenous to Brazil. Inferior varieties of it are produced by species of *Castilloa* and other plants growing in tropical climates. It occurs associated with fat, albumin, resin, etc., in the milky juice or latex of the plants, which is obtained by incision. By coagulation of the albumin contained in the exuded juice, the suspended particles of caoutchouc are collected in a curdy mass, which becomes tough and elastic when dry. The finest quality is that known in commerce as pure Pará rubber, and that alone should be used for official purposes.

**Characters.**—Pará rubber occurs in elastic masses of varying form and size, which are brownish-black externally, the colour shading off into a paler tint internally. Each mass consists of a number of thin layers, which appear to be separated by dark lines, the superposition being due to the coagulation of successive coats of the alkaline latex by exposure to acid vapours contained in the smoke from burning wood. Some rubber is milk-white internally, and little, if any, can properly be described as “mottled.” India-rubber is insoluble in water, ethylic alcohol, alkaline solutions, or dilute acids, but is more

or less soluble in chloroform, oil of turpentine, carbon bisulphide, benzol, and petroleum spirit. It has a characteristic, somewhat empyreumatic, odour, is nearly tasteless, and melts at about  $125^{\circ}$  C., remaining soft and adhesive after cooling.

**Notes.**—India-rubber swells and becomes soft and gelatinous in chloroform, benzene, and other solvents, a portion of it appearing to dissolve, whilst the rest remains in a more or less disintegrated condition. Pará rubber contains from 40 to 60 per cent. of pure caoutchouc or caoutchouc-gutta, 30 to 50 per cent. of a gelatinous substance, and small quantities of fat, resin, colouring matter, and mineral substances. Alcohol removes from Pará rubber about 1·5 per cent. of resin. Inferior rubber contains less of the gelatinous substance and more resin. When india-rubber is subjected to dry distillation, oil of caoutchouc—a mixture of various hydrocarbons, including isoprene and dipentene—is obtained. Pure caoutchouc is a white, amorphous substance— $(C_{10}H_{16})_x$ —which can be obtained by dissolving the crude material in chloroform and precipitating with alcohol. It absorbs oxygen from the air, and is converted into vulcanite when treated under pressure with sulphur.

## Capsici Fructus.

**Capsicum** is the dried ripe fruit of *Capsicum minimum*, Roxburgh (N. O. Solanaceæ), a small erect shrub with spreading branches, which is probably a native of Southern India, and is cultivated in India, Eastern Africa, South America, and other tropical countries. The fruit is collected when ripe and dried.

**Characters and Test.**—Capsicum fruit is scarlet when fresh, but of a dull orange-red colour when dried. It is oblong-conical in shape, obtuse at the apex, from 12 to 20 Mm. in length, and does not exceed 6 Mm. in diameter. The fruit is superior, and sometimes remains attached to a small, inconspicuous, five-toothed, inferior calyx and a straight, slender peduncle about the same length as the fruit, or rather longer. The pericarp of the fruit is somewhat shrivelled and flattened; it is glabrous, shining, more or less translucent, and also leathery in texture. A transverse section of the fruit shows that it is two-celled, each cell containing from five to ten small, flat, whitish seeds, either loose or attached to the thin, reddish, membranous dissepiment which separates the two cells. The seeds are nearly circular in shape, and have a characteristic thickened margin. The odour of capsicum fruits is characteristic and the taste intensely pungent, being most marked in the dissepiment that divides the fruit. On incineration, powdered capsicum should not yield more than 6 per cent. of ash, thus showing freedom from adulteration with inorganic substances.

**Notes.**—The fruits of *Capsicum annum*, Linné, cultivated in Europe, are large, with a short peduncle and conspicuous green calyx; the fruits of *C. frutescens*, Linné, and other species cultivated in tropical countries can only be distinguished from those of *C. minimum* by minute differences in their external appearance. The chief constituent of capsicum fruit is about 0·02 per cent. of capsaicin,  $C_9H_{14}O_2$  or  $C_{18}H_{28}NO_2$ , to which its pungency is due; it has been isolated in a crystalline form, and is contained chiefly in the dissepiment.



ment, being secreted by the cells of the epidermis between the cuticle and the outer cell-wall. Other constituents of the fruit are fixed oil, red colouring matter, and a volatile liquid alkaloid which is not pungent; the seeds may contain traces of starch.

## Carbo Ligni.

**Wood Charcoal** is the carbonaceous residue of wood charred by exposure to a red heat without access of air, the wood of the beech, hazel, oak, poplar, and willow being employed for the purpose.

**Characters and Test.**—Wood charcoal is a black, tasteless, and odourless powder, free from gritty matter; it should not leave more than 10 per cent. of ash when heated to a high temperature, with free access of air, and may leave considerably less.

**Notes.**—The distinctive characters of official wood charcoal are its freedom from taste and odour, and the small proportion of inorganic matter left when the powder is burned. The quantity of ash depends chiefly upon the kind of wood from which the charcoal is prepared, but the official maximum—7.5 per cent.—will distinguish wood charcoal from bone-black and animal charcoal, prepared by heating bones in partly-closed iron vessels; those substances may contain as much as 90 per cent. of calcium phosphate and carbonate, and are not free from taste and odour, even when purified. [*Dose.*—60 to 120 grains.]

## Carbonis Bisulphidum.

**Carbon Bisulphide** is prepared by passing sulphur vapour over red-hot charcoal and condensing the resulting vapours. The raw product contains, besides the carbon bisulphide formed by direct union of the elements, dissolved sulphur and numerous strong smelling organic sulphur compounds. It is purified from the sulphur by careful distillation, and the unpleasant odorous impurities may be more or less removed by treatment with fat, sodium, potassium permanganate, mercury and mercuric sulphate, nitric acid or bromine, and subsequent redistillation.

**Characters and Tests** —Carbon bisulphide is a clear, colourless, highly refractive liquid, having a characteristic but not fetid odour. When quite pure the odour is not unpleasant, but on keeping, especially if exposed to light, it decomposes, with formation of unpleasant smelling compounds. Specific gravity, 1.268 to 1.269. Boiling point, 46° to 47° C. It is very slightly soluble in water and weak alcohol, soluble in absolute alcohol, ether, chloroform, and the fixed and volatile oils. It evaporates rapidly at ordinary temperatures, and is highly inflammable, burning with a bright blue flame, and producing carbonic and sulphurous anhydrides. It should not affect the colour of blue litmus paper moistened with water. Evaporated spontaneously in a glass vessel it should leave no residue, showing absence of free sulphur, which might be present in an old decomposed sample or one imperfectly rectified. Shaken with solution of lead acetate, the latter should not be blackened, indicating absence of hydrogen sulphide.

**Notes.**—Carbon bisulphide finds technical application as a solvent of iodine, sulphur, phosphorus, fats, etc., and in the vulcanisation of rubber. In organic chemistry it is often used as a solvent or diluent for substances which are to be submitted to chlorination or bromination, since, in the absence of water and at ordinary temperature, it is only slowly attacked by the free halogens.

## Cardamomi Semina.

**Cardamom Seeds** are obtained from *Elettaria Cardamomum*, Maton (N.O. Scitamineæ), a plant which grows wild in the forests of Southern India, and is cultivated near the Malabar coast, as well as in Ceylon. The inflorescence of the plant is a long, loose raceme, and the small, inferior, capsular fruits are cut from the rachis before they are quite ripe. They are then bleached and cured by exposure to the sun whilst wet, the bleaching being sometimes assisted by subjecting the fruits to the action of steam and then exposing them to the vapour of sulphurous acid. The cured fruits are trimmed and freed from impurities by picking. The dried, ripened seeds should be preserved in their pericarps until required for use; fruits which have fully ripened on the plant open and discharge the seeds, which are then exported freed from their pericarps, but such seeds are excluded by the official description.

**Characters and Tests.**—Cardamom fruits occur in several varieties, which differ in size and shape. They are usually from 10 to 20 Mm. in length, ovoid or oblong in shape, bluntly triangular in section and three-celled; they are also usually shortly beaked at the apex with the remains of the calyx, pale buff or yellowish in colour and longitudinally striated, though sometimes they are nearly smooth, the striations having disappeared during the process of bleaching. Each cell contains two rows of small dark reddish-brown seeds, about 3 Mm. in diameter, attached to axile placentas; those are irregularly angular in shape, transversely wrinkled, and enclosed in thin, colourless, membranous arils, which become more evident when the seeds are soaked in water. The hilum is depressed and the position of the raphe is indicated by a channel extending from the base to the apex of the seed on one side. A transverse section of a seed shows a thin dark seed-coat, enclosing a whitish perisperm grooved on one side, a small yellowish translucent endosperm, and a minute embryo. The odour and taste of the seeds are agreeably warm and aromatic, owing to the presence of volatile oil, of which they may contain as much as 5 per cent. The powdered drug should not yield more than 6 per cent. of ash; good ripe seeds yield only from 3.5 to 5.5 per cent., but unripe seeds yield more.

**Notes.**—Mysore, Malabar, and Mangalore cardamoms all meet the official requirements. The first-mentioned are the largest, varying from about 6 to 20 Mm. in length; their cream colour and the smoothness of their pericarps are due to the use of artificial bleaching agents. Malabar cardamoms are somewhat smaller, rarely exceeding 12 Mm. in length; they are generally pale brown or yellowish in colour, have a pointed apex, and are longitudinally striated. Mangalore cardamoms are less common than the

other two varieties; they resemble the Malabar fruits, but are small and almost globular in shape. Grey cardamom seeds and shrivelled (unripe) seeds are inferior and should not be used. Ceylon (wild) cardamom fruits, the product of *Elettaria Cardamomum*, var.  *$\beta$ -major*, Smith, vary in length from 25 to 38 Mm., are commonly greyish-brown in colour, and not plump in appearance; the seeds are larger and paler than those of Malabar cardamoms. Siam cardamoms, from *Amomum cardamomum*, Linné, and Korarima cardamoms, from *A. korarima*, Pereira, are also occasionally met with. Grains of Paradise, *Amomum* sp., are distinguished from cardamom seeds by their rich reddish-brown colour, minutely and irregularly wrinkled surface, and the presence of the remains of a thick fibrous funicle. The chief constituent of cardamom seeds is from 2 to 8 per cent. of volatile oil, containing terpinene, terpineol, and either limonene or dipentene; other constituents of the seeds are 10 to 11 per cent. of fixed oil, starch, albuminoids, mucilage, and sometimes cobalt or manganese. The mineral constituents of the seeds are not constant, even in one and the same variety, and the amount of ash yielded on incineration varies largely.

### Carui Fructus.

**Caraway Fruit** is the product of *Carum Carvi*, Linné (N.O. Umbelliferae), an erect biennial herb distributed over Central and Northern Europe, and cultivated in Holland, Germany, Sweden, Norway, Russia, France, Mogador, and England. The inferior two-celled ovary of the caraway develops into a cremocarp (schizocarp), the component carpels (mericarps) of which separate by splitting away from the central axis or carpophore, without liberating the seeds.

**Characters and Tests.**—Caraway fruit usually consists of the separate mericarps, which are each 4 to 6 Mm. long and about 1 Mm. broad. They are quite glabrous, brown in colour, slightly curved, tapering towards the ends, and traversed from base to apex by five narrow, yellow, primary ridges. Each ridge contains a fibro-vascular bundle, and is thus distinguished from the secondary ridges on coriander and other umbelliferous fruits. There are no secondary ridges on caraway fruits, but in the depressions between the primary ridges are situated elongated vittæ or oil glands, imbedded in the pericarp and extending from base to apex of the fruits. Four such vittæ occur on the dorsal or outer side of the mericarp, between the ridges, and two on the commissural or inner surface, by which it was originally attached to the carpophore. The vittæ are best seen in a transverse section, appearing as minute dark-brown spots or cavities. The section will also exhibit the narrow pericarp, enclosing a large oily endosperm which is not grooved near the commissural surface; the embryo occurs near the apex of the fruit. The agreeable aromatic odour and taste of the fruit are due to the presence of volatile oil. Caraway fruit or powder should not yield more than 6 to 8 per cent. of ash on incineration, this test serving to detect the presence of sand or other extraneous mineral substances.

**Notes.**—The distinctive characters of caraway fruits are their glabrous surface, the presence of six vittæ in each mericarp, and the ungrooved endosperm. English caraways are of brighter tint than the Dutch, the latter being of a dark brown colour. Russian fruits are smaller and often mixed with



much dirt and débris of the fruit stalks; Mogador fruits are large and pale in colour. The volatile oil, of which about 3·5 to 7 per cent. can be obtained from the fruit by distillation, contains carvone, which is also found in oil of dill. Other constituents of the fruit are fixed oil, resin, sugar, mucilage, and a little tannin.

## Caryophyllum.

**Cloves** are the dried flower-buds of *Eugenia caryophyllata*, Thunberg (N.O. Myrtaceæ), an evergreen tree native to the Molucca Islands, where it is still cultivated, though the bulk of the cloves now produced come from the islands of Zanzibar and Pemba. Small quantities are also exported from Java, Ceylon, the Seychelles, etc. The inflorescence of the plant is a compound raceme which bears white buds that turn green as they develop, and finally become crimson. They are collected before the corolla expands and dried in the sun, the crimson colour changing to dark reddish-brown in the process.

**Characters and Tests.**—Cloves are about 15 Mm. long, and consist of the dark-brown, wrinkled, nearly cylindrical, but somewhat angular calyx tubes, which taper downwards and are each crowned by four thick, rigid, divergent teeth, within which appear four paler-coloured, unexpanded, overlapping petals. On removing the petals, after soaking for twenty-four hours in water, the presence is disclosed of a stiff, erect style and numerous stamens; the style arises from a small disc, below which is a two-celled ovary containing numerous ovules. The solid, fleshy, lower part of the clove contains a large number of oil-glands and similar glands occur in the calyx-teeth and petals. The volatile oil present imparts a fragrant, spicy odour and a pungent, aromatic taste. It should be emitted on indenting the cloves with the finger-nail, and they should also sink in water, thus showing that the oil has not been removed. On incineration, cloves should not leave more than 5 to 7 per cent. of ash, the absence of clove stalks—and, in the case of powdered cloves, inorganic adulterants—being thus indicated.

**Notes.**—The cloves imported from the Molucca Islands are the best, those from Penang being large, and of a bright brown colour, and those from Amboyna rather smaller and of a darker brown. Zanzibar and Pemba cloves are still smaller, dark coloured, with the buds frequently broken, and with stalks and foreign matters intermixed. Spent cloves, “clove stalks” or peduncles, and “mother cloves” or ripe clove fruits have been used as adulterants of whole and powdered cloves. The first emit no oil when indented with the finger-nail and do not sink in water, the other two are readily distinguished by their general appearance, also by their microscopic characters. The stalks are dry and woody, contain much less oil than cloves, and yield a greater percentage of ash. The ripe fruits are ovoid in shape, brown, about 25 Mm. long, and contain but little oil; they also contain starch, which is not present in the flower-buds. Cloves contain from 10 to 13 per cent. of tannin (gallotannic acid); also gum, resin, wax, caryophyllin (a phytosterin), and about 15 to 20 per cent. of volatile oil which consists almost entirely of eugenol and caryophyllene.

## Cascara Sagrada.

**Cascara Sagrada** or **Sacred Bark** is the dried bark of *Rhamnus Purshianus*, De Candolle (N.O. Rhamnæ), a shrub which grows freely in North California and in the States of Oregon and Washington, U.S.A. It is collected in the spring and early summer, when it is easily peeled from the wood, and curls into quills on drying. If collected later, the bark must be cut away, and portions of wood are then apt to be removed with it. The bark should be kept for at least twelve months after collection before being used.

**Characters.**—Cascara sagrada usually occurs in straight, stiff, single quills, or in channelled or nearly flat pieces, about 10 Cm. long, 18 Mm. wide, and 1.5 Mm. thick. The quills vary from 6 to 25 Mm. in diameter, and pieces of the drug may be obtained as much as 10 Cm. wide, 15 Cm. long, and 4.5 Mm. thick, but the thinner bark is preferable. The corky outer layer of the bark is nearly smooth, of a dark, purplish-brown colour, and marked with scattered, transversely elongated, whitish lenticels. Beneath the cork is a yellowish-grey cortex, in which groups of sclerenchymatous cells form dark, translucent points, and wavy medullary rays may be perceived in the brownish-yellow bast when a smoothed, transverse section is examined by the aid of a lens. The greyish-white appearance of the drug in places is due to patches of silvery-grey lichen, which conceal the cork and lenticels; when those patches are removed by scraping, the exposed cork appears at first of a brownish-red colour. The inner surface of the bark is dark reddish-brown, with faint transverse corrugations and longitudinal striations. The bark breaks with a short fracture, which is somewhat fibrous near the inner surface, where the bast occurs. The characteristic odour of the drug is not very powerful, but its taste is persistent, nauseous, and bitter. The bitter taste can be removed, more or less completely, by treatment with alkalies, as in preparing the so-called "tasteless" extracts of cascara. The bark yields about 5 per cent. of ash.

**Notes.**—The bark of *R. californicus*, which is known in California as "cascara sagrada," has been substituted for that of *R. Purshianus*; it is said to be distinguishable by the uniform coat of lichen, the somewhat reddish, dull-grey cork, the small number of lenticels, and the paler inner surface. The chief purgative principle of cascara sagrada is still unknown. Emodin and frangula-emodin are constituents of the bark, but the bitterness of the drug is probably chiefly due to an anhydride or lactone which, in the presence of an alkali, is converted into an alkaline salt devoid of bitterness, and possessing little, if any, of the purgative properties of the original bitter substance. The bark also contains about 2 per cent. of fat, glucose, and a hydrolytic enzyme. Cascarin and purshianin, which have been alleged to be present in the bark, are probably impure substances. The constituents of the drug appear to undergo change on keeping, as the action of the bark is milder and less emetic when it has been kept for a year or more before use.

## Cascarilla.

**Cascarilla** is the dried bark of *Croton Eluteria*, J. J. Bennett (N.O. Euphorbiaceæ), a shrub which is indigenous to the Bahama Islands. The bark appears to be taken from twigs, branches, and small stems.

**Characters.**—Cascarilla is imported in single quills, from 2·5 to 7·5 Cm. or more in length and from 4 to 12 Mm. in diameter; also in small curved or channelled pieces. The outer layer of the bark is dull-brown or dark-grey in colour, longitudinally wrinkled, and frequently marked with small transverse and longitudinal cracks, which give it a chequered appearance. A characteristic chalky appearance is presented by the bark, owing to the presence in the cells of numerous crystals of calcium oxalate. The patchy appearance in places is caused by the dark-coloured cortex showing through the white or greyish-white cork, and the minute black dots seen on larger pieces of the bark are the apothecia of a small lichen. The cork is easily separated, and reveals the brown or dark-grey cortex marked with longitudinal and transverse furrows. The bark breaks with a short and resinous fracture; a transverse section exhibits under a lens the pale cork layer, dark-brown cortex, and dark reddish-brown bast traversed by numerous thin, whitish medullary rays. No groups of sclerenchymatous cells can be detected, cascarilla being thus distinguished from other barks which are sometimes mixed with it. The agreeable aromatic odour of cascarilla is more marked when the bark is burned; the taste is also aromatic, but disagreeably bitter. The bark should not yield more than 10 per cent. of ash.

**Notes.**—The barks of other species of *Croton* are distinguished from cascarilla by the absence of the aromatic odour, bitter taste, and sclerenchymatous cells. The bitter principle is a crystalline substance named cascarillin; the bark also contains a crystalline alkaloid named cascarilline, betaine—a base akin to choline—resin, starch, gum, pectin, a little tannin, and about 1 per cent. of a volatile oil (specific gravity, 0·890 to 0·925), which consists chiefly of cymene, sesquiterpenes, alcohols, 1-limonene, and a terpene boiling at 155°-157° C., together with traces of eugenol, cresol, resin, and cascarillic, palmitic, and stearic acids.

## Cassiæ Pulpa.

**Cassia Pulp** is obtained from the fruits of *Cassia Fistula*, Linné (N.O. Leguminosæ), a tree indigenous to India. The inflorescence of the tree is a pendulous raceme, and each flower has a one-celled, many-seeded ovary, which develops into a long pod, with a thin, hard, and woody pericarp, differing from an ordinary legume in being indehiscent as well as many-celled.

**Characters.**—Cassia pods are from 35 to 50 Cm. long, and from 18 to 25 Mm. in diameter, nearly straight and cylindrical in shape, with a short stalk, and of a dark chocolate-brown colour. They are very hard and indehiscent. The dorsal and ventral sutures are marked by two smooth bands running the whole length of the fruit, but they are not prominent. Internally, each pod is divided into numerous compartments by thin transverse partitions or spurious dissepiments, placed about 6 Mm. apart. Each division contains a single smooth, flattish-oval, reddish-brown seed, attached to the ventral suture by a



long, dark, thread-like funiculus; adhering to each membranous partition is a thin layer of the nearly black viscid pulp, which has a faint, somewhat sickly odour and a sweetish taste.

**Notes.**—Cassia pulp, of which the pods yield about 30 per cent., contains more than half its weight of sugar, together with mucilage, pectin, calcium oxalate, and albuminoid matter. Old pods, recognised by the rattling of the seeds when shaken, yield dried pulp, which should not be used. The pods of *Cassia grandis* are official in France; they are usually longer, thicker, and heavier than those of *C. Fistula*, with a rough surface, laterally compressed seeds, one prominent ridge on the dorsal suture and two on the ventral suture. The pods of *C. moschata* are also official in France; they are smaller and narrower than the pods of *C. Fistula*, while the pulp is paler in colour and exhales a musky odour when warmed. No definite purgative principle appears to have been isolated from the pulp.

## Catechu.

**Catechu Pallidum**, also known as gambier or “terra japonica,” is an extract prepared from the leaves and young shoots of *Uncaria Gambier*, Roxburgh (N.O. Rubiaceæ), a climbing shrub indigenous to the Malay Archipelago and largely cultivated in many of the islands. On boiling the leaves and young shoots with water, evaporating the resulting decoction to a syrupy consistence, and cooling, a soft clayey mass is obtained, in which crystallisation is induced by agitation. The crystalline mass is allowed to drain, then cut into small cubes, strips, plates, or discs, and dried.

**Characters and Tests.**—Pale catechu usually occurs in more or less agglutinated cubes, measuring about 25 Mm. each way. They are fairly regular in shape, deep reddish-brown externally, pale cinnamon-brown internally, porous, friable and very light. When examined under a microscope, preferably after mixing a little with a drop of oil, the extract is seen to consist chiefly of minute acicular crystals. It is free from odour, but has a taste which is at first bitter and astringent, and afterwards sweetish. It should dissolve almost entirely in boiling water, yield 70 to 80 per cent. of matter to 90 per cent. alcohol, contain no starch, and leave not more than 5 per cent. of ash when incinerated.

**Notes.**—Starch, clay, or other inorganic matter, and other plant extracts, are possible adulterants of pale catechu. Starch can be detected by submitting the residue left after exhausting the drug with cold water to microscopical examination; clay and other inorganic matters increase the amount of ash left on incineration; other plant extracts differ in solubility and do not contain any fluorescent substance. The chief constituents of pale catechu are 7 to 33 per cent. of catechin (catechuin or catechuic acid), and 22 to 50 per cent. of catechutannic acid, the proportions varying according to the care with which the drug has been prepared. It also contains quercetin, catechu-red—a decomposition product of catechutannic acid, which is itself produced from catechin by loss of a molecule of water—and gambier-fluorescin, a fluorescent substance not found in black catechu and many similar extracts. Catechin forms white,

silky crystals; catechutannic acid has been obtained as a reddish, amorphous powder, which yields catechu-red when boiled with water or a dilute mineral acid.

[Dose.—5 to 15 grains.

## Cera Alba.

**White Beeswax** is the wax separated from the honeycomb of the hive bee, *Apis mellifica*, Linné (Order Hymenoptera), bleached by exposing thin bands of the natural yellow wax for several weeks to the action of air, sunlight, and moisture, besides being remelted, if necessary, so as to expose fresh surfaces. Bleaching may also be effected by the aid of chemicals, such as chromic or nitric acid, but white wax so prepared is excluded by the official description.

**Characters and Tests.**—White beeswax occurs in hard, nearly white, translucent masses, and should respond to the same tests as yellow beeswax. It is entirely soluble in oil of turpentine, insoluble in cold 90 per cent. alcohol, but soluble in about 100 parts of boiling alcohol; it is also soluble to a slight but variable extent in cold ether and in 10 parts of boiling ether.

**Notes.**—Possible adulterants of white beeswax are lard, tallow, paraffin, starch, or mineral substances, such as kaolin. Lard or tallow renders the wax soft and lessens its specific gravity; paraffin is not affected by sulphuric acid; starch and inorganic impurities are insoluble in oil of turpentine; moreover, starch gives a characteristic blue coloration when the wax containing it is boiled with water, and solution of iodine added to the cooled liquid.

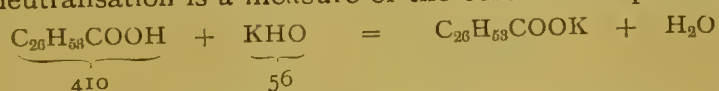
## Cera Flava.

**Yellow Beeswax** is a secretion formed by the hive bee, *Apis mellifica*, Linné (Order Hymenoptera), and used by that insect to make the walls of the cells of which the honeycomb consists. After the honey has been extracted, the wax is melted with water, separated, and strained.

**Characters and Tests.**—Yellow beeswax, when pure, is firm, breaking with a granular fracture; it is yellowish-brown in colour, has an agreeable honey-like odour, and is not unctuous to the touch. It is soluble in chloroform, and in fixed and volatile oils, should dissolve entirely in hot oil of turpentine, but should not yield more than 50 per cent. to cold ether, nor more than 3 per cent. to cold alcohol, nor more than 1 per cent. to boiling water. The specific gravity of beeswax varies from 0.958 to 0.970, and its melting point from 61° to 64° C., the solidifying point being two or three degrees lower. If beeswax should contain fatty acids, resin, or Japan wax, those impurities may be detected by their solubility in boiling sodium hydroxide solution, the filtered liquids becoming turbid on adding hydrochloric acid, owing to the separation of free fatty acids, or even yielding a precipitate thereof. On melting 5 grammes of beeswax in boiling 90 per cent. alcohol and mixing it therewith, not less than 1.6 C.c. of normal alcoholic volumetric solution of potassium hydroxide will be required to effect neutralisation, whilst upon adding 20 C.c. more of the volumetric solution and well boiling for one hour under a reflux condenser, from 6.2 to 6.8 C.c. should combine with the beeswax. This saponification test shows the freedom or otherwise from paraffin, fats, etc. Paraffin separates unaltered

if 5 grammes of beeswax containing it be heated for 15 minutes to 160° C. with 25 grammes of strong sulphuric acid, though the beeswax is completely charred by the acid. The absence of starch is indicated by the iodine test.

**Notes.**—The chief constituents of beeswax are about 15 per cent. of cerotic acid (cerin),  $C_{26}H_{58}COOH$ , a homologue of acetic acid, and more than 80 per cent. of myricin or myricyl (melissyl) palmitate,  $C_{15}H_{31}COOC_{30}H_{61}$ , the palmitic ester of myricyl (melissyl) alcohol,  $C_{30}H_{61}OH$ . An aromatic body, cerolein, also occurs in beeswax, as well as colouring matter, and probably traces of myricyl (melissyl) stearate. Most substances used to adulterate beeswax affect its specific gravity, melting point, and ratio of free acid to ester number. The chief adulterants met with are resin, paraffin, and other waxes; mineral substances used as adulterants are insoluble in hot oil of turpentine, as are also starch, flour, etc. Resin and stearic acid are soluble in 90 per cent. alcohol; soap dissolves in hot water, and the solution becomes cloudy on adding hydrochloric acid, owing to the separation of fatty acids; paraffin reduces the density of the wax and the amount of potassium hydroxide required for complete saponification, whereas lard, tallow and other fats require more alkali to effect complete saponification than is needed in the case of beeswax. Aqueous solution of sodium hydroxide saponifies tallow, suet, Japan wax, fats, etc., but an alcoholic solution is required to saponify beeswax. Any beeswax below specific gravity 0.960 is probably adulterated with paraffin wax. In taking the melting point the capillary tube into which the liquefied wax has been introduced is to be set aside for three hours before being used for the melting point determination. If the melting point be taken immediately after solidification in the capillary tube the observed value varies considerably for the same sample, and is lower than the constant value observed for wax which has been allowed to stand some time. The quantity of potassium hydroxide required for neutralisation is a measure of the cerotic acid present.



From this equation it is seen that each cubic centimetre of normal potassium hydroxide solution, containing 0.056 gramme KHO, will neutralise 0.410 gramme of cerotic acid. Hence 1.6 C.c. N/1 KHO solution indicates  $0.410 \times 1.6 = 0.656$  gramme free acid in 5 grammes of beeswax taken for analysis, equivalent to 13.12 per cent. If now an excess of alcoholic potash solution (20 C.c.) be added and the mixture boiled for one hour under a reflux condenser (to avoid loss of alcohol) the myricin (myricyl palmitate) will be saponified.



From this equation it is obvious that each cubic centimetre of normal potassium hydroxide solution is capable of saponifying 0.676 gramme of myricin. When the saponification is complete the product is titrated back to neutrality with normal acid solution, so as to find the quantity of potash



solution actually consumed by saponification. The pharmacopœial limits work out as follows:—

6.2 C.c. N/1 KHO	=	4.19 grammes myricin	83.8 per cent.
6.8 C.c. „	=	4.597 „	91.9 „

These free acid and saponification numbers are valuable factors in determining the purity of beeswax, since all the possible adulterants increase or diminish either one or the other and so alter the ratio of the two figures. In the sulphuric acid test for paraffin the sample is heated with excess of acid, which completely chars the beeswax, but leaves the paraffin unaffected. The charred mixture, after cooling, is washed with water to remove acid and then with alcohol to remove adhering water. The black residue is next exhausted with ether; that dissolves the paraffin wax, which may be separated and weighed by evaporating the ethereal solution.

## Cerii Oxalas.

**Cerium Oxalate**,  $\text{Ce}_2(\text{C}_2\text{O}_4)_3, 9\text{H}_2\text{O}$ , may be obtained by interaction of a soluble cerium salt and a soluble oxalate. It usually contains some lanthanum and didymium oxalates.

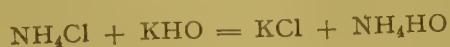
**Characters and Tests.**—Cerium oxalate is an almost white, granular powder, insoluble in water, decomposed at a dull red heat, yielding a reddish brown residue of oxide which dissolves in boiling hydrochloric acid forming a solution of cerium chloride,  $\text{Ce}_2\text{Cl}_6$ . This solution gives with a saturated solution of potassium sulphate a white crystalline precipitate consisting of a double sulphate of cerium and potassium  $\text{K}_3\text{Ce}(\text{SO}_4)_3$  or  $3\text{K}_2\text{SO}_4, \text{Ce}_2(\text{SO}_4)_3$ . Effervescence of the ignited residue during solution in hydrochloric acid would indicate presence of an oxalate of an alkali or alkaline earth, since those are only converted into carbonate at a low red heat. When incinerated it loses 53 per cent. in weight, *i.e.*, the residue of oxide is equal to 47 per cent. of the oxalate. This corresponds closely to the proportion  $\text{Ce}_2(\text{C}_2\text{O}_4)_3, 9\text{H}_2\text{O} : \text{Ce}_2\text{O}_3$ . for—

$$701.34 : 326.04 :: 100 : 46.5.$$

Cerium oxalate should be free from arsenium, iron, aluminium, zinc, calcium, carbonates, and phosphates.

**Notes.**—Cerium, in the course of analysis, is precipitated with the metals of the iron group, *i.e.*, its chloride is soluble in water, it does not form a sulphide insoluble in dilute acid, but insoluble cerium hydroxide is precipitated by ammonia. Cerium occurs in nature associated with lanthanum and didymium, and the reactions and solubilities of the various salts of these three metals are so similar that their separation in an absolutely pure condition is rendered very difficult; consequently cerium oxalate, as found in commerce, contains small quantities of didymium and lanthanum oxalates. If cerium oxalate be quite pure the residue of cerium oxide after ignition would be yellow—the reddish-brown colour mentioned in the Pharmacopœia is due to didymium oxide. The metals of the cerium group are distinguished by the formation of insoluble double sulphates with potassium. Iron, aluminium, and chromium form double

sulphates soluble in water. Alumina, as an impurity, is detected by boiling with potash, which precipitates cerium hydroxide; the aluminium hydroxide, being soluble in this reagent, is looked for in the filtrate in the usual manner—addition of ammonium chloride, which effects the substitution of free ammonia, in which aluminium hydroxide is insoluble, for potash—



Ignition of a metallic oxalate may result in production of—

- (i.) A carbonate (sodium or potassium).
- (ii.) An oxide, if the corresponding carbonate be easily decomposed by heat (iron and cerium), or—
- (iii.) A metal, if the carbonate and oxide are both decomposed at the temperature employed (silver).

[Dose.—2 to 10 grains.]

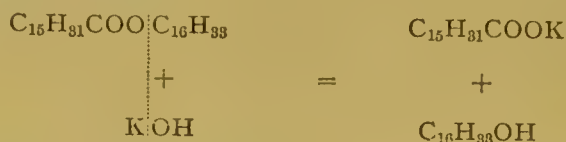
## Cetaceum.

**Spermaceti** is a concrete, fatty substance, which crystallises from the oil obtained from the sperm whale, *Physeter macrocephalus*, Linné (Order Cetacea). The oil is contained chiefly in a huge cavity in the head of the whale, but also occurs in smaller cavities in the body. The crystalline matter deposited on keeping is separated by filtration, pressed, melted, and purified from the last traces of oil by washing with dilute sodium hydroxide solution, being subsequently separated from the soap produced and freed from excess of alkali.

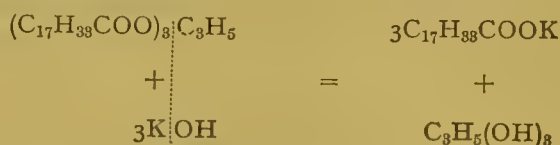
**Characters and Tests.**—Spermaceti occurs in crystalline, pearly-white, glistening masses, which are translucent, slightly unctuous to the touch, and have but little taste or odour. It can be reduced to powder by the aid of a little 90 per cent. alcohol. It is insoluble in water, nearly insoluble in cold 90 per cent. alcohol, but soluble in ether, chloroform, boiling alcohol, and in fixed or volatile oils. It should melt at 46° to 50° C., and not more than one drop of volumetric solution of sodium hydroxide should be required to neutralise 0.2 gramme when dissolved in 20 C.c. of 90 per cent. alcohol. The latter test indicates the absence of stearic or other fatty acid. Stearic acid, if present, is also precipitated on boiling spermaceti with 90 per cent. alcohol, cooling the mixture, filtering to remove the separated spermaceti, and adding water to the filtrate.

**Notes.**—The distinctive characters of spermaceti are its pearly, crystalline appearance, and the minute quantity of free fatty acid it contains. It consists almost entirely of cetyl palmitate (cetin),  $\text{C}_{15}\text{H}_{31}\text{COO}\cdot\text{C}_{16}\text{H}_{33}$ , the palmitic ester of cetyl alcohol,  $\text{C}_{16}\text{H}_{33}\text{OH}$ , together with small quantities of closely allied homologous esters. As cetyl alcohol is one of the higher homologues of methyl alcohol, its formula,  $\text{C}_{16}\text{H}_{33}\text{OH}$ , follows the general formula for the alcohols of that series,  $\text{C}_n\text{H}_{2n+1}(\text{OH})$ . Since it contains sixteen carbon atoms in the molecule its systematic name is hexadecyl alcohol. Note that spermaceti contains no glycerides, and hence yields no glycerin on saponification. If

spermaceti be saponified by alcoholic potash, potassium palmitate and cetyl alcohol are the main products:—



It will be noted that one molecule of cetyl palmitate is thus saponified by one molecule of potassium hydroxide, since cetyl alcohol is a monohydric alcohol. On the other hand, each molecule of the glyceryl esters of fatty acids requires three molecules of potassium hydroxide, because glycerin is a trihydric alcohol. Thus for glyceryl oleate we have:—



Consequently much less potash is required for the saponification of a given weight of spermaceti than for an equal weight of those oils and fats which consist chiefly of glycerides. From this it follows that the saponification equivalent of spermaceti, *i.e.*, the number of grammes saponified by 1 litre of normal potassium hydroxide solution, is represented by a comparatively high figure, viz., about 440. The molecular weight of pure cetyl palmitate is 480, and it will be seen by reference to the equation representing its saponification that this figure represents also its saponification equivalent. The saponification equivalent of spermaceti itself, as mentioned above, is about 440. This difference is explained by the observation that in addition to cetyl palmitate spermaceti contains small quantities of homologous esters of lower molecular weight, which consequently require more potassium hydroxide than an equal weight of cetyl palmitate. In the official characters and tests the behaviour of spermaceti to cold and hot alcohol should be noted. It is dissolved entirely by hot 90 per cent. alcohol, and practically entirely deposited on cooling. Paraffin wax and several other possible adulterants are detected by this test. Since spermaceti, unless rancid, contains no free acid, its solution in hot alcohol, under the conditions described, should be rendered alkaline by the first drop of normal sodium hydroxide solution added. The test for stearic acid (and other solid fatty acids) is really unnecessary, since their presence will have been revealed by the test for "limit of acidity." The test as described depends upon the insolubility of spermaceti and the solubility of free fatty acids in cold alcohol. The fatty acids are, however, precipitated from their alcoholic solution when this is diluted with water.

## Charta Sinapis.

**Mustard Paper** is prepared by exhausting a mixture of equal parts of bruised black and white mustard seeds by percolation with benzol to remove fixed oil. The oil-free residue is then finely powdered, mixed with solution of



indiarubber, the mixture spread on cartridge paper, and allowed to dry by exposure to air.

**Notes.**—The sinigrin in the mustard is not soluble in benzol. The removal of the oil by the benzol enables the water, with which the paper should be moistened before application, to penetrate the particles of mustard more freely, and so bring about the hydrolysis of the glucoside by the ferment.

## Chirata.

**Chiretta** or **Chirayta** is the dried plant, *Swertia Chirata*, Hamilton (N.O. Gentianæ), an erect herb, indigenous to the mountainous districts of Northern India. The entire plant is collected when flowering is well advanced and many fruits are formed, dried, and made into bundles about a metre in length, and weighing from 700 to 900 grammes each.

**Characters.**—Chiretta has a smooth yellowish-brown or purplish-brown stem, about a metre in length, slightly winged and much branched above, and rounded below. It contains a large, continuous, easily separable pith, enclosed by a narrow ring of wood and a very thin bark. The slender, elongated branches are arranged in a decussate manner, *i.e.*, successive opposite pairs are at right angles to each other; the branches in turn ramify further and bear numerous flowers and fruits. Root oblique. The few leaves usually present are opposite and sessile, ovate to lanceolate in shape, and taper-pointed. The surface of the leaf is smooth, the margin entire, and there are usually three to seven lateral veins. The flowers are officially described as numerous, though not many are present in the drug; they are small, with yellow rotate corolla, and paniced, the inflorescence being a paniced cyme. The superior unilocular or one-celled fruits are formed from two carpels, and contain numerous minute reticulated seeds. The drug has no marked odour, but an extremely bitter taste.

**Notes.**—The distinctive characters of chiretta are the brown colour of the stem, large continuous pith, intensely bitter taste, opposite leaves, and bicarpellary, unilocular fruits. Other species of *Swertia*, which are sometimes found mixed with chiretta, can be distinguished from it by the first three characters; the other two serve to distinguish chiretta from plants belonging to other natural orders, such as *Andrographis paniculata*, Nees (N.O. Acanthaceæ). The root of *Rubia cordifolia*, Linné (N.O. Rubiaceæ), has also been found included in bundles of chiretta. The tapering root of chiretta attains a length of about 10 Cm., and may measure about 12 Mm. in thickness at the crown. It is less frequently branched than the stem, but always bears some rootlets. In stronger specimens the root is somewhat oblique, the stem in such cases being probably the product of a second year's growth. Chiretta contains two yellow, intensely bitter principles, ophelic acid and chiratin, the latter of which is decomposed by acids into ophelic acid and chiratogenin.

## Chloral Hydras.

**Chloral Hydrate**, or trichlorethylidene glycol, is obtained by the addition of water to the liquid chloral produced by the action of dry chlorine gas on

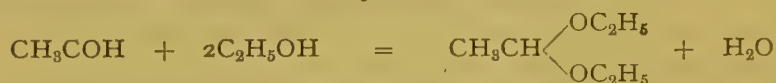
ethylic alcohol. The operation extends over several days, the chlorine being passed into the alcohol in a slow stream. The reaction-mixture is at first kept cool, the temperature being raised towards the end of the process. The whole then sets, on cooling, to a crystalline mass consisting chiefly of chloral alcoholate. This is treated with strong sulphuric acid, which decomposes the compound into alcohol and chloral, the latter forming an oily layer floating on the acid. The oily layer is washed with a little water, chalk being added to neutralise adherent acid, then distilled and combined with the necessary quantity of water to form the hydrate. The reaction between chlorine and absolute alcohol is very complicated and results in the production of several chlorinated derivatives of alcohol, *e.g.*, ethyl chloride, ethylene chloride, tri-chlor-ethyl alcohol, etc., from which the chloral must be freed before it is fit for medicinal use. The formation of chloral is sometimes explained by assuming that the alcohol is converted into aldehyde by the withdrawal of hydrogen—



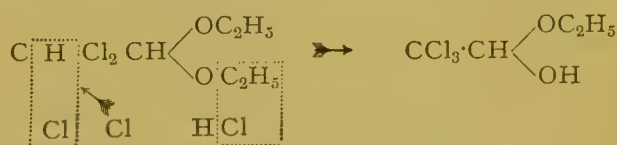
the aldehyde being then converted into tri-chlor-aldehyde by substitution—



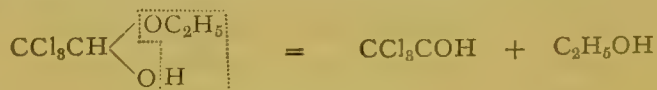
The production of ethyl chloride, among other substances, and the appearance of chloral alcoholate as the chief end product of the reaction indicate, however, that the reactions are not so simple. One of the intermediate products is acetal, formed by condensation between aldehyde and alcohol—



This is then chlorinated to dichloroacetal, which by further chlorination and under the influence of the hydrochloric acid present is converted into chloral alcoholate—

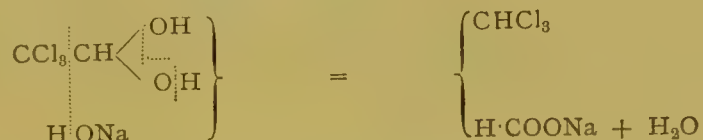


The chloral alcoholate when treated with strong sulphuric acid is converted into chloral by withdrawal of a molecule of ethyl alcohol by the acid—



**Characters and Tests.**—Chloral hydrate occurs in colourless monoclinic plates, which do not deliquesce on exposure to air. It has a pungent but not an acrid odour, and a pungent and rather bitter taste. Soluble in less than its own weight of water, 90 per cent. alcohol, or ether, and in four times its weight of chloroform. The aqueous solution is neutral or but slightly acid to litmus, showing that it has been properly purified from the acid by-products produced in its manufacture. On the application of heat, chloral hydrate fuses to a colourless liquid, which, as it cools, begins to solidify at a temperature of about 48.9° C. In a test tube it boils, when pieces of broken glass are

immersed in it, at from  $94.4^{\circ}$  to  $96.7^{\circ}$  C., being dissociated into chloral and water as is shown by the determination of its vapour density. Heated on platinum foil it volatilises without residue. In presence of alkaline substances chloral hydrate is decomposed and chloroform is liberated. If 4 grammes be heated with 30 C.c. of normal solution of sodium hydroxide, not more than 6 C.c. of normal solution of sulphuric acid should be required to neutralise the soda which remains free on the completion of the reaction. This quantitative test for purity is based upon the decomposition of chloral hydrate by caustic alkalis into chloroform and alkali formate—



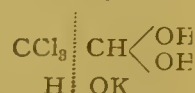
The 1885 B.P. directed that the chloroform produced should be separated by distillation, collected, and weighed. This method involves two obvious sources of variation in the result, viz., the difficulty of collecting the whole of the volatile chloroform, and its solubility in the supernatant water, which distils with it. According to the equation given above, 1 molecular weight NaOH (39.76) reacts with 1 molecular weight chloral hydrate (164.15). Each C.c. of normal sodium hydroxide solution contains 0.03976 gramme NaOH, and will be equivalent to 0.1641 gramme of chloral hydrate. Therefore, the 24 C.c. of sodium hydroxide solution, which are required to be neutralised by the formic acid produced, in the official test (30—6) indicate  $0.16415 \times 24 = 3.9396$  grammes of chloral hydrate in the 4 grammes taken for analysis, or 98.49 per cent. A solution in chloroform when mixed by agitation with sulphuric acid does not impart colour to the acid, showing the absence of certain easily charred organic impurities. When 1 gramme of chloral hydrate is warmed with 6 C.c. of water and 0.5 C.c. of solution of potassium hydroxide, the mixture filtered (to separate the chloroform), sufficient solution of iodine added to impart a deep brown colour, and the whole set aside for an hour, a yellow crystalline precipitate of iodoform should not result. The iodoform test is intended to detect the presence of chloral alcoholate, one of the intermediate bodies produced in the preparation of chloral. It is an ethyl derivative of chloral hydrate, and when decomposed by alkali, splits off alcohol (compare preceding equation) instead of water—



The alcohol thus produced then reacts with iodine in presence of alkali to produce a crystalline deposit of iodoform. The aqueous solution of chloral hydrate should not afford any precipitate with solution of silver nitrate showing absence of chlorides, more particularly hydrochloric acid which may be present as a result of the decomposition to which badly-prepared samples are liable.



**Notes.**—Chloral is trichloroacetic aldehyde,  $\text{CCl}_3\text{C}\cdot\text{O}\cdot\text{H}$ . Chloral hydrate,  $\text{CCl}_3\text{CH}\begin{smallmatrix} \text{OH} \\ \diagup \\ \text{OH} \end{smallmatrix}$ , exhibits an uncommon feature, namely, the presence of two hydroxyl groups combined with the same carbon atom. As a general rule attempts to prepare bodies containing the group  $=\text{C}\begin{smallmatrix} \text{OH} \\ \diagup \\ \text{OH} \end{smallmatrix}$  result in the production of the carbonyl group  $=\text{CO}$ , the elements of a molecule of water separating (compare carbonic acid,  $\text{OC}\begin{smallmatrix} \text{OH} \\ \diagup \\ \text{OH} \end{smallmatrix} = \text{CO}_2 + \text{H}_2\text{O}$ ). When chlorine (or some other negative element or group) is united to a neighbouring carbon atom, the formation of the group  $=\text{C}\begin{smallmatrix} \text{OH} \\ \diagup \\ \text{OH} \end{smallmatrix}$  is rendered possible. When chloral hydrate is decomposed by alkalis into chloroform and formic acid, thus—



the group  $-\text{CH}\begin{smallmatrix} \text{OH} \\ \diagup \\ \text{O} \end{smallmatrix} \begin{smallmatrix} \text{H} \\ \diagdown \end{smallmatrix}$  breaks up into  $-\text{C}\begin{smallmatrix} \text{O} \\ \diagup \\ \text{H} \end{smallmatrix}$  and  $\text{H}_2\text{O}$ , owing to the removal of

the influence of the chlorine. A very delicate test for the chloroform produced when chloral hydrate is decomposed by alkali, is to add a drop of aniline to the reaction mixture and warm gently for two or three minutes; a very penetrating and nauseous odour of phenyl-isocyanide is given off—



This test is useful to distinguish more certainly between chloral hydrate and butyl-chloral hydrate. The latter body does not produce chloroform when decomposed by alkalis, but it does produce allylene dichloride (*vide* Butyl-Chloral Hydras), and this body has an odour which may be mistaken for that of chloroform. The test with aniline serves to distinguish them with certainty, because allylene dichloride does not give the isocyanide reaction. It is interesting to note that the formation of chloroform from chloral by the action of alkalis first suggested to Liebreich the use of chloral, since he considered it possible that it might undergo the same change in the body. The action of the drug was thus discovered, although the supposition that chloroform is produced in the body has not been confirmed. Instead of this change chloral seems to undergo reduction and be excreted from the body as urochloralic acid, a body which on hydrolysis yields trichlorethyl alcohol and glycuronic acid, the latter body being nearly related to the sugars. The quantitative test for chloral hydrate given in the Pharmacopœia does not seem to be altogether satisfactory, because the excess of alkali acts upon the chloroform produced, so that unless the test be quickly performed an appreciable quantity of sodium hydroxide is used up in this way and too high results are obtained. It may be observed that no temperature or time limit for heating the alkali and chloral hydrate solution is given in the official directions.

[Dose.—5 to 20 grains.]

## Chloroformum.

**Chloroform**, or trichloromethane,  $\text{CHCl}_3$ , to which has been added sufficient absolute alcohol to produce a liquid having a specific gravity not

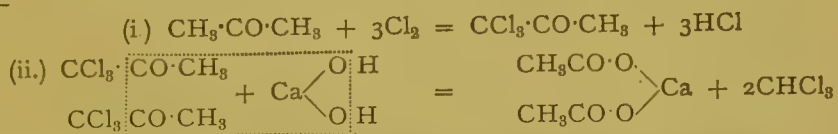
less than 1.490 and not more than 1.495. Pure chloroform has a specific gravity of 1.502 at 15° C.; the addition of about 1 per cent. of ethylic alcohol reduces its density to between the figures given above, the addition serving the useful purpose of protecting the chloroform from decomposition to which it is liable on keeping. Chloroform is made by three processes:—

1. By distilling a mixture of chlorinated lime, water, and alcohol. The distillate separates into two layers—an upper aqueous layer and a lower layer of impure chloroform. The explanation usually given for the reactions which take place is that the chlorinated lime (by virtue of the chlorine it can yield) converts the alcohol into aldehyde, and that is chlorinated to tri-chloraldehyde, which is decomposed by the lime, with formation of chloroform and calcium formate, thus—

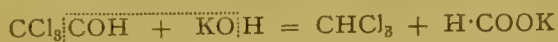


This process should be compared with that by which chloral hydrate is manufactured.

2. By distilling acetone with chlorinated lime and water as in process (1). In this case tri-chloracetone is formed and this yields chloroform and calcium acetate—



3. By the action of alkalis on chloral, or on chloral hydrate.



The raw chloroform requires careful purification to free it from various other chlorinated bodies produced simultaneously by secondary reactions. This is accomplished by successive treatment with concentrated sulphuric acid, soda or lime, washing with water, and redistillation from quicklime. About 1 per cent. of absolute alcohol is then added to preserve the chloroform.

**Characters and Tests.**—Chloroform is a liquid of characteristic odour and pungent sweet taste. Specific gravity 1.490 to 1.495. It should boil between 60° and 62° C. (pure chloroform boils at 61° C.). On allowing 20 C.c. to evaporate from a large piece of filter paper placed on a warm plate, no foreign odour should be perceptible at any stage of the evaporation. This test is very effectual in discovering impurities which have not been removed from the raw chloroform by purification, or which are formed by decomposition through careless storage. The nose should be closely applied to the filter paper during the later stages of the evaporation. Acid impurities may be detected by agitating chloroform with twice its bulk of water, and, after separation, testing the aqueous layer with litmus. The aqueous layer also should not give a blue colour with solution of cadmium iodide (which is more stable than potassium iodide and less liable to contain free iodine) and mucilage of starch, showing absence of free chlorine; nor any precipitate with solution of silver nitrate (absence of hydrochloric acid). After shaking sulphuric acid with ten times its volume of chloroform and setting aside for fifteen minutes (in a clean and dry stoppered bottle), both the acid and the chloroform should be perfectly transparent and nearly colourless. Sulphuric acid under these conditions has no

action on pure chloroform, this test, like the "smell" test, being intended to detect the presence of organic impurities, which are easily charred by the strong sulphuric acid. The 1 per cent. alcohol present in the official chloroform imparts only a pale straw colour to the acid layer. Certain impurities may, however, be present which are withdrawn from the chloroform, and, like chloroform, not charred. Two C.c. of the acid should, therefore, be withdrawn and diluted with 5 C.c. of water; the liquid should remain transparent (the impurities may be soluble in strong but not in dilute acid), and have a pleasant odour. This acid liquid, further diluted with 10 C.c. of water, should give no precipitate with silver nitrate, showing that no chlorinated compounds are present which yield hydrochloric acid with strong sulphuric acid. A further test for chlorinated compounds is made by shaking the chloroform, which has been agitated with sulphuric acid, with twice its bulk of water; the aqueous layer should not afford a precipitate on the addition of silver nitrate solution. Chloroform should evaporate without leaving any residue.

**Notes.**—Absolutely pure chloroform is said to be a very unstable substance, its decomposition being accelerated by exposure to light and air. The decomposition products are exceedingly complex, but are chiefly free chlorine or pungent-smelling substances having a very irritating action upon the mucous membrane of the nose and throat. Such decomposed chloroform is therefore unfit for anæsthetic purposes. The preservative action of added alcohol (preferably 2 per cent.) is supposed to be due, in part, at least, to the alcohol reacting with the decomposition products to form harmless compounds, but the cause cannot yet be said to be thoroughly explained. It has been stated that the fatal effects sometimes attending the use of chloroform are due to impurities; this, however, is highly improbable, because samples of chloroform which have caused death have often been examined and have proved to be free from impurity other than the added alcohol. The so-called methylated chloroform of commerce is prepared from methylated spirit. If properly purified it is identical with the chloroform from rectified spirit, because any products formed from the naphtha used for "methylating" the spirit are completely separated during purification and rectification. Chloroform should be preserved in a cool and dark place. [Dose.—1 to 5 minims.

## Chrysarobinum.

**Chrysarobin** is a substance obtained from Araroba or Goa powder by extracting the crude drug with chloroform, evaporating the solution to dryness, and powdering the residue. In addition to chrysarobin it contains dichrysarobin methyl ether and other substances.

**Characters and Tests.**—Chrysarobin is a crystalline yellow, tasteless, inodorous powder. It is entirely soluble in hot chloroform and almost so in hot 90 per cent. alcohol, partially soluble in petroleum spirit, but only slightly soluble in water. The drug dissolves partially in potassium hydroxide solution, and assumes a deep brownish-red colour. It melts when heated with free access of air, giving off yellow fumes, and leaves not more than 1 per cent. of ash on incineration.



**Notes.**—Chrysarobin, properly so-called, is rapidly oxidised to chrysophanic acid when dissolved by a strong alkali, the solution turning from yellowish-brown to deep red, a change which may be hastened by passing a current of air through the solution. The chrysophanic acid formed dissolves readily in dilute caustic alkalies, yielding deep red solutions.

## Cimicifugæ Rhizoma.

**Cimicifuga** or **Actææ Racemosæ Radix**, consists of the dried rhizome and roots of *Cimicifuga racemosa*, Nuttall (N.O. Ranunculaceæ), a tall, herbaceous plant, which grows freely in shady woods in Canada and the United States. The plant produces a stout rhizome, which is collected in the autumn—after the fruit has formed and the leaves have died down—cut into pieces and dried.

**Characters and Test.**—*Cimicifuga* is a thick, hard, and knotty horizontal rhizome, from 5 to 15 Cm. long, and from 12 to 25 Mm. in diameter. It is nearly cylindrical in shape, and bears the remains of numerous stout ascending branches, which are about 25 Mm. or more in length, about 9 Mm. in thickness, and so close together as almost to conceal the rhizome. The branches curve upwards and terminate in the remains of a bud, or in a circular cup-shaped scar which exhibits a distinctly radiate structure. Encircling scars of cataphyllary leaves mark the rhizome and its branches, being more conspicuous on the latter. The straight, stout, dark-brown roots, which are given off from the under surface of the rhizome, are obscurely quadrangular or longitudinally furrowed; they are brittle, usually broken off quite close to the rhizome, and exhibit in transverse section from three to five, or even six—but usually three or four—wedge-shaped bundles of porous whitish wood, separated by broad and dark medullary rays. A similar section of the rhizome or one of its branches exhibits a large dark-coloured horny pith, surrounded by a ring of numerous pale wedges of wood, alternating with wide dark medullary rays outside which is a thin dark horny bark or cortex. An infusion of *cimicifuga* is darkened by test-solution of ferric chloride. This reaction distinguishes the drug from black hellebore, and is due to the presence of tannin. The odour of *cimicifuga* is faint and not characteristic; its bitter, acrid taste is due to the presence of *racemosin*. The drug yields about 7 per cent. of ash.

**Notes.**—The distinctive characters of *cimicifuga* are the numerous stout branches curving upwards, and the appearance of transverse sections of the rhizome and roots. Black hellebore rhizome, which has been confused with it, is tortuous, and its irregular branches are not prominently curved upwards; sections of the rhizome show a thicker bark and fewer wood bundles than *cimicifuga*, and in sections of the roots the wood is much less distinctly cruciate. *Cimicifuga* contains the crystalline, bitter substance *racemosin*, together with tannin, sugar, various acids, a phytosterol, and a trace of alkaloidal matter. *Cimicifugin* or *macrotin* is an amorphous, resinous mixture obtained by pouring a strongly alcoholic tincture of *cimicifuga* into water.

## Cinchonæ Rubræ Cortex.

**Red Cinchona Bark** is obtained from the stem and branches of cultivated plants of *Cinchona succirubra*, Pavon (N.O. Rubiaceæ), and imported chiefly from India, though bark corresponding to the official description and test is occasionally received from Jamaica, Ceylon, and elsewhere.

**Characters and Tests.**—Red cinchona bark occurs in quilled or more or less incurved pieces, coated with the periderm, and varying in length from 5 to 30 Cm. or more. The bark is usually from 2.5 to 6 Mm. thick, and the quills vary in size, but are often about 35 Mm. in diameter. The outer surface of the bark is brownish or reddish-brown, and often bears greyish lichens; it is also more or less rough from longitudinal ridges and numerous reddish warts or enlarged lenticels which often run into lines in the larger pieces of bark. The ridges are most apparent in the bark obtained from the branches; in some varieties (*e.g.*, Jamaica bark, from *C. succirubra*, var. *subpubescens*) there are numerous transverse cracks, the edges of which are not thickened or raised. The inner surface of the bark is brick-red or deep reddish-brown, but when the exposed portion is cut away, the surface appears of a yellowish-brown colour, which darkens on exposure owing to a change in the tannin of the bark, by which a reddish phlobaphene is produced. Other features of the bark are the irregularly and coarsely striated appearance of its inner surface, the fibrous fracture—short in smaller and fine in larger pieces, the brownish or reddish-brown colour of the powder, the bitter and astringent taste, and the absence of any marked odour. When used for making galenical preparations, it should yield from 5 to 6 per cent. of total alkaloid, of which not less than half should consist of quinine and cinchonidine. The reason for this proviso is that the medicinal value of the cinchona alkaloids is believed to be as follows:—Quinine first, then quinidine, cinchonidine, cinchonine, and, lastly, amorphous alkaloid. Quinidine usually occurs in comparatively small quantities. The determination of total alkaloids is therefore not sufficient, since a large proportion might be cinchonine and amorphous alkaloid, and a bark, although containing 6 per cent. of total alkaloids, would be of low medicinal value under those conditions.

**ASSAY PROCESS.**—The official assay process needs but little explanation. Trituration with lime sets free the alkaloids from their natural combinations, and they are then dissolved out from the mixture by repeated treatment with benzolated amylic alcohol. This fluid also dissolves colouring matter and traces of other bodies, so that simple evaporation to dryness would not yield a sufficiently pure residue to be weighed as alkaloid. In order to separate the alkaloids from accompanying impurities a procedure is adopted which is very commonly employed in alkaloidal assays, *viz.*, the conversion of a dissolved substance into a condition in which it is more soluble in a second, immiscible, solvent than in the original solvent. In the present instance that result is attained by first adding dilute hydrochloric acid to convert the alkaloids into hydrochlorides. Those salts are very slightly soluble in benzolated amylic alcohol, but very freely so in water, especially in presence of an excess of acid. When the two fluids have separated the lower aqueous layer will contain nearly all the alkaloidal salts, and

reagitation with a fresh portion of water removes practically the whole. It is advisable not to shake the two fluids together too violently, otherwise they will emulsify to some extent, and not separate quickly or completely. If an emulsified layer is in any case obtained, only the perfectly clear portion should be drawn off, and more solvent added to wash the alkaloid out of the emulsified portion. Gently rotating and warming will sometimes assist complete separation. Note that the general rule in such separations is that the alkaloidal salts, in presence of acid, pass from oily or ethereal fluids into water, and the free alkaloids, liberated from the acid aqueous solution by addition of alkali, pass from water to oily or ethereal solvent. This, of course, depends upon the fact that free alkaloids are, as a rule, only slightly soluble in water, while their salts, particularly in presence of excess of acid, are freely soluble in water. The fluids, immiscible with water, most commonly employed are ether, chloroform, benzene, and amylic alcohol, the choice of fluid depending upon the solubility of the alkaloid dealt with. The general statement which covers all these cases is as follows:—When two non-miscible fluids are agitated with a substance soluble in both, the substance distributes itself between the two solvents in a ratio which is directly proportional to its solubility in those solvents. From this it follows that the greater the difference between the solubility of any substance in the two fluids, the more easily and completely is it extracted from the one in which it is least soluble.

**Notes.**—The distinctive characters of red cinchona bark are its quilled or incurved appearance, spongy texture, longitudinal wrinkles, and reddish warts. There are several other quilled cinchona barks, none of which meets the official requirements. That from *C. Calisaya* is firm and hard, with well-marked longitudinal and transverse cracks, and an outer corky layer which shows a tendency to exfoliate in flakes; the bark of *C. Ledgeriana* is similar, but has fewer and less conspicuous fissures. The bark of *C. officinalis* has numerous small transverse and longitudinal cracks, and the quills are usually small and rough, with thickened edges. That of *C. lancifolia* has a more or less uniformly smooth surface, with patches of silvery-grey cork and a very fibrous fracture. The chief constituents of cinchona barks are the alkaloids quinine, cinchonidine, cinchonine, and quinidine; other constituents are hydroquinine, hydrocinchonidine, quinamine, homocinchonidine, quinovin—a bitter amorphous glucoside, quinic or kinic acid, cinchotannic acid (the peculiar tannin which yields, on oxidation, the reddish phlobaphene, cinchona red), starch, calcium oxalate, gum, sugar, wax, and a trace of volatile oil. In addition to the alkaloids named, various others have been produced by the action of heat or different reagents on the normal constituents of the bark. Red cinchona bark of average quality contains about 1.5 per cent. of quinine, 2.5 per cent. of cinchonidine, 1.0 per cent. of cinchonine, and 0.8 per cent. of amorphous alkaloids; total alkaloid, 5.8 per cent.

### Cinnamomi Cortex.

**Cinnamon Bark** is the dried inner bark of shoots from the truncated stocks of *Cinnamomum zeylanicum*, Breyne (N.O. Laurineæ), a small evergreen



tree, indigenous to Ceylon, and cultivated in that island. Ceylon cinnamon from cultivated trees is alone official. The shoots are cut down when nearly two years old and from 1 to 2 metres long; the bark is then removed in strips, which are exposed in heaps for about twenty-four hours, and afterwards freed from epidermis and cortex by scraping. The strips are next packed inside one another, rolled into sticks and dried.

**Characters.**—Cinnamon bark occurs in closely rolled quills, each about a metre or more long, from 6 to 9 Mm. in diameter, and containing numerous and very short quills or channelled pieces. The quills are dull pale yellowish-brown externally, and somewhat darker on the inner surface. They are extremely thin, brittle, splintery, and marked by small scars or holes (indicating the insertion of leaves or lateral shoots), and faint shining wavy lines, formed by bundles of bast fibres. A transverse section shows an outer pale layer of sclerenchymatous cells and an inner dark layer of bast. The fragrant odour and aromatic taste are due to the presence of volatile oil. Ash-yield, 4 to 5 per cent.

**Notes.**—The distinctive characters of cinnamon bark are the compound quills, uniform colour, absence of cork, narrow wavy longitudinal lines, odour, and taste. The commercial varieties differ in the thinness and smoothness of the quills, which also vary considerably in size. Cinnamon of good quality comes from Southern India, and inferior varieties from Brazil, the West Indies, and Java. Cassia bark, from *Cinnamomum Cassia*, Blume (N.O. Lauraceæ), resembles cinnamon in odour and taste, but is less delicate in aroma and more mucilaginous and astringent. It occurs in thicker, usually single, quills, which are darker in colour than cinnamon and bear patches of cork. The chief constituent of the bark is the volatile oil, of which it yields 0.5 to 1.0 per cent.; other constituents are tannin and mucilage.

## Cocæ Folia.

**Coca Leaves** are obtained from *Erythroxylum Coca*, Lamarck (N.O. Linææ), and varieties of that species. The leaves are picked twice a year, or oftener, and dried. The plants are cultivated in Bolivia and Peru, the dried leaves imported from those two countries constituting well-marked varieties and being known commercially as Huanuco (Bolivian) and Truxillo (Peruvian) coca leaves. Those two varieties are alone official, other kinds—such as Java and Ceylon coca, which are used solely by cocaine manufacturers—being less constant in the quantity of cocaine present, and apt to contain other alkaloids of toxic nature.

**Characters.**—Bolivian (Huanuco) coca leaves, which are said to be obtained from *E. Coca*, var. *bolivianum*, Burck, very usually from 3.5 to 7 Cm. in length, and from 25 to 35 Mm. in breadth, but much smaller leaves may be found. They have a characteristic brownish-green colour, oval outline, and entire margin; both surfaces are glabrous, the upper surface bearing a distinct ridge above the midrib, and the under surface showing two curved lines near the midrib, running from the base to the acute apex of the leaf. The blade tapers in both directions, the midrib projecting at the apex in the form of a minute horny apiculus or point, which, however, is frequently

broken off. In a transverse section of the leaf, examined under the microscope, most of the epidermal cells of the under surface are seen to project in the form of small papillæ. The odour of the drug is faint but characteristic, and its slightly bitter taste is succeeded by a sensation of numbness in the mouth, owing to the local anæsthetic action of the cocaine present. The leaves should be free from mildew, because their alkaloidal content diminishes rapidly when they are not carefully preserved. Peruvian (Truxillo) coca consists of leaves from *E. Coca*, var. *novo-granatense*, Morris, or *E. truxillense*, Rusby; they are somewhat smaller, narrower, and more fragile than those imported from Bolivia, pale green in colour, without the prominent ridge above the midrib on the upper surface, and with less distinct curved lines near the midrib on the under surface.

**Notes.**—The distinctive characters of coca leaves are the curved lines on the under surface, the minute horny apiculus, and the characteristic odour and taste. The midrib in Huanuco coca lies in a slight depression, as is usually apparent when the upper surface of a leaf is examined with a lens. The two curved lines are much less distinct on the under surface of Truxillo coca, there is no ridge above the midrib on the upper surface, and the network of small veins is less close and less prominent. The flowers of a species of *Inga* are frequently found in Truxillo coca, being apparently added with the view of improving the drug; they are about an inch long, with a yellowish-brown, tubular, hairy calyx and numerous deep red filaments forming a plume. The most important constituent of coca leaves is cocaine, or methyl-benzoyl-ecgonine, of which the quantity is usually less than 1 per cent., Bolivian coca containing more than Peruvian. The total alkaloids present, of which about two-thirds may be cocaine, do not usually exceed 1.5 per cent., and the average amount is 0.5 per cent. Other alkaloids found, in addition to cocaine, are cinnamyl-cocaine and isatropyl-cocaine (truxilline or cocamine), which are frequently present in Truxillo coca in larger quantity than cocaine. Benzoyl-ecgonine and hygrine (?) are also found, as well as cocatannic acid, methyl salicylate, and wax. When hydrolysed by heating to 100° C. with hydrochloric acid, cocaine yields methyl alcohol, benzoic acid, and a crystalline alkaloid—ecgonine, which is very closely allied to tropine. In the case of cinnamyl-cocaine the result is similar, except that cinnamic acid is formed in place of benzoic acid. Isatropyl-cocaine, in like manner, yields isotropic (truxillic or cocaic) acid. Benzoyl-ecgonine is an intermediate product of the complete hydrolysis of cocaine. It can be split into benzoic acid and ecgonine; by methylation it can be converted into cocaine. Java coca, from *E. Coca*, var. *spruceanum*, Burck, contains cocamine and benzoyl pseudo-tropeine, the latter, when hydrolysed, yielding benzoic acid and pseudo-tropine—an isomer of tropine. Ceylon coca leaves correspond in physical characters to the Huanuco variety. Like the Java leaves, they are not so rich in cocaine as Bolivian and Peruvian coca, although sometimes richer in total alkaloid.

## Cocaina.

Cocaine,  $C_{17}H_{21}NO_4$ , is an alkaloid obtained from the leaves of *Erythroxylum Coca*, Lamarck, and its varieties. It can be extracted by means of 2 to 5

per cent. sulphuric acid, the resulting solution being subsequently freed from colouring matter, etc., and the alkaloid precipitated by the addition of excess of sodium carbonate, after which it is purified by crystallisation from ether or other suitable solvent.

**Characters and Tests.** — Cocaine forms colourless monoclinic prisms which have a bitter taste followed by a sensation of tingling and numbness. Melting point  $96^{\circ}$  to  $98^{\circ}$  C. Almost insoluble in water, insoluble in glycerin, soluble in 10 parts 90 per cent. alcohol, 4 parts of ether,  $\frac{1}{2}$  part of chloroform, in 12 parts of olive oil, and in 14 parts of turpentine. Dissolved in water acidulated with hydrochloric acid (to form cocaine hydrochloride which is soluble) the solution or the solid salt obtained by evaporating it to dryness should afford the reactions mentioned under Cocainæ Hydrochloridum. Its solution in water acidulated with nitric acid should afford no reaction with the tests for chlorides or sulphates.

## Cocainæ Hydrochloridum.

**Cocaine Hydrochloride**,  $C_{17}H_{21}NO_4$ , HCl, is the salt of an alkaloid obtained from the leaves of *Erythroxylum Coca*, Lamarck, and its varieties. Since the alkaloid contained in coca leaves suffers some decomposition during the voyage, the crude alkaloid is extracted in South America and purified in Europe.

**Characters and Tests.** — Cocaine hydrochloride occurs in colourless acicular crystals, or as a crystalline powder. Melting point  $180^{\circ}$  to  $186^{\circ}$  C. Soluble in half its weight of cold water, forming a clear and colourless solution, neutral to litmus, and in 4 times its weight of 90 per cent. alcohol or glycerin. It is insoluble in olive oil and in ether, thus differing from the free alkaloid. Its aqueous solution has a bitter taste, produces a tingling sensation followed by numbness on the tongue, and dilates the pupil when applied to the eye. It affords with a solution of auric chloride a yellow precipitate of cocaine aurochloride; a white precipitate of cocaine with solution of ammonium carbonate, and a white precipitate of borate with solution of borax. It dissolves without colour in cold sulphuric or nitric acid (this distinguishes it from many alkaloids and glucosides which give colour reactions with  $H_2SO_4$  and  $HNO_3$ ), but chars with hot sulphuric acid, evolving an agreeable odour and yielding a crystalline sublimate of benzoic acid, which is one of the decomposition products of cocaine. The aqueous solution yields with solution of potassium hydroxide a white precipitate of cocaine, which is soluble in alcohol or ether, and with solution of picric acid a yellow precipitate of cocaine picrate becoming crystalline on standing, with test solution of mercuric chloride slightly acidulated with hydrochloric acid a white precipitate soluble in hot water. Moistened with nitric acid, the mixture evaporated to dryness, and a drop of alcoholic solution of potassium hydroxide added, a characteristic odour is evolved more or less recalling that of peppermint. A solution containing not less than 1 per cent. gives with excess of solution of potassium permanganate a copious red precipitate of cocaine permanganate which does not change colour within an hour. If the salt contains any cinnamyl-cocaine, cocamine, or other constituents of



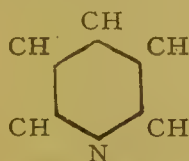
crude coca alkaloids the permanganate will be decolorised within this time. 0.1 gramme dissolved in 100 C.c. of water and 0.25 C.c. of solution of ammonia added (the mixture should be vigorously stirred or whipped with a glass rod in a measure glass) afford a clear solution from which a crystalline deposit should separate on stirring. This test, which is a modification of what is known as MacLagan's test, is based upon the following facts:—The alkaloid cocaine is very slightly soluble in water. If a solution of the hydrochloride be taken of such a strength that it will yield, on the addition of ammonia, slightly more cocaine than the water will retain in solution, then the excess will be deposited slowly in a distinctly crystalline form. If the salt contain any amorphous coca alkaloids or the impurities mentioned later, the crystalline character of the precipitate will be wanting; the precipitate will be sticky, and if much impurity be present the supernatant fluid will be milky instead of clear. The reaction mixture becomes quite clear after standing some time, owing to the hydrolysis of the cocaine into methyl alcohol and benzoyl-ecgonine which is more soluble than cocaine. Cocaine hydrochloride should afford the reactions characteristic of chlorides and contain only minute traces of sulphate. It contains no water of crystallisation, and should not lose more than 1 per cent. of moisture when heated for twenty minutes to 95° to 100° C. Heated to redness with free access of air it burns without residue.

**Notes.**—Coca leaves contain, besides cocaine, several other alkaloids nearly related to it; some of those have no local anæsthetic effect, and others, while exhibiting anæsthetic properties, have an irritant or toxic effect. All these bases undergo hydrolysis when heated with hydrochloric acid or alcoholic potash, and by a study of these hydrolytic products a knowledge of the constitution of cocaine and its relation to the allied bases has been obtained. The hydrolysis of cocaine takes place in two stages:—

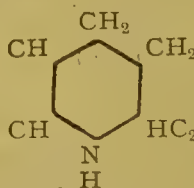
(i.) Cocainæ + 1 mol. water = Benzoyl-ecgonine + methyl alcohol.

(ii.) Benzoyl-ecgonine + 1 mol. water = Ecgonine + benzoic acid.

The nitrogen remains in the ecgonine, which is a basic body derived from tetra-hydro-pyridine—



Pyridine.

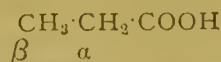


Tetra-hydro-pyridine.

Ecgonine is methyl-tetrahydro-pyridyl- $\beta$ -hydroxy-propionic acid. Its constitution will be understood from the following description, propionic acid being the next homologue to acetic acid:—



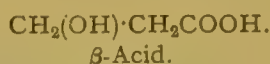
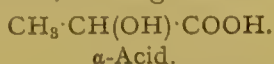
Acetic Acid.



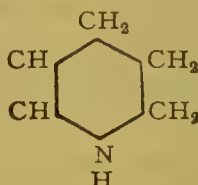
Propionic Acid.

In propionic acid and the higher homologues possessing a carbon chain of three or more carbon atoms, the carbon atoms are distinguished by the Greek letters  $\alpha$ ,  $\beta$ ,  $\gamma$ , etc., starting at the one next the carboxyl group. This is done in order

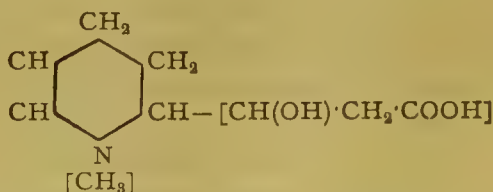
to systematise the nomenclature of the derivatives. For instance, there are two isomeric hydroxy-propionic acids,  $C_2H_4(OH)COOH$ , and these are distinguished as  $\alpha$  and  $\beta$  acids, having the following formulæ—



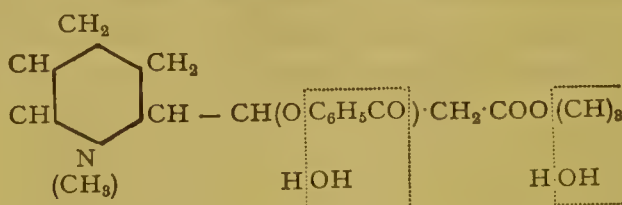
There are several possible formulæ for methyl-tetrahydro-pyridine according to the relative position of the four added hydrogen atoms and the substituting methyl group. The tetra-hydro-pyridine nucleus in ecgonine probably has the constitution expressed by the formula—



and ecgonine itself



Cocaine is then methyl-benzoyl-ecgonine; the hydrogen in the alcoholic hydroxyl of the side chain of the ecgonine being substituted by benzoyl ( $C_6H_5CO-$ ), the acid radical of benzoic acid (compare acetyl  $CH_3CO-$  and acetic acid  $CH_3COOH$ ), while the hydrogen of the carboxyl group is replaced by methyl. Its constitution and hydrolysis will be easily understood from the next formula, to which two molecules of water are apposed, the dotted lines indicating the manner in which the hydrolytic products are formed—



The other alkaloids of cocaine are similarly constituted derivatives of ecgonine. The two chief accompanying alkaloids are (1) cinnamyl-cocaine, so called because it contains the cinnamyl radical,  $C_6H_5 \cdot CH:CH \cdot CO$ , in place of benzoyl, and consequently yields cinnamic acid instead of benzoic acid on hydrolysis, and (2) cocamine. The last mentioned has also been described as isotropyl-cocaine and truxilline. By hydrolysis it yields a compound called cocaic or isotropic acid, instead of benzoic acid. The occurrence of those in impure cocaine hydrochloride is shown by the rapid reduction of potassium permanganate and consequent decolorisation when a solution of this salt is added to the cocaine solution. Cinnamyl-cocaine, cocamine, and amorphous coca alkaloids (like many other alkaloids and organic substances generally) are rapidly oxidised by potassium permanganate.

[Dose.— $\frac{1}{5}$  to  $\frac{1}{2}$  grain.]

## Coccus.

**Cochineal** is the dried fecundated female insect, *Coccus Cacti*, Linné (Order Hemiptera), a native of Central America and Mexico, but also bred in the Canary Islands. The insects are reared upon the fleshy branches of *Nopalea coccinellifera*, Salm-Dyck (N.O. Cactaceæ), and are normally of a bluish-red colour, and about 1.25 Mm. in length, the males alone being provided with wings. After fecundation the females increase in size rapidly, and develop an abundance of red colouring matter, though a waxy secretion with which their bodies are covered gives them a whitish appearance. At this stage they are brushed off the plants, killed, and dried, being thereby reduced to one-third their original size or less. If the insects are killed by the fumes of burning sulphur or charcoal and dried in the sun, the waxy secretion remains unaffected, and "silver-grain" cochineal is the result; but if killed by hot water or in an oven and dried by artificial heat "black-grain" cochineal is obtained, the waxy secretion being removed and the colour of the insects changing to a reddish or purplish black.

**Characters and Tests.**—Cochineal insects, when dried, are about 5 Mm. long, oval in outline, flattish or slightly concave on one side, convex or arched on the other. In colour they are purplish-grey or purplish-black and, if properly dried, they can easily be reduced to a puce-coloured or dark-red powder. The dried insects are transversely wrinkled and swell considerably when macerated in water, three pairs of legs being then rendered visible in each case. Cochineal is sometimes faced, in the case of the "silver-grain" variety, with barium or lead carbonate or sulphate, whilst "black-grain" cochineal may be faced with black lead, ivory black, or manganese dioxide. All such additions can be detected by macerating the cochineal in water, as insoluble powders then separate. Inorganic impurities also increase the amount of ash—which should not exceed 6 per cent.—left on incineration with free access of air.

**Notes.**—The chief constituent of cochineal is about 10 per cent. of a red colouring matter—carminic acid—which is obtainable in small, red, prismatic crystals, and is soluble in water, alcohol, and alkaline solutions. Other constituents of cochineal are about 10 per cent. of fat and 2 per cent. of wax (coccerin), together with albuminoids, inorganic matter, etc. Carmine is a colouring matter obtained by precipitating a decoction of cochineal with alum, potassium bitartrate, etc., in the presence of lime salts, and albumen; it contains about 50 per cent. of carminic acid.

## Codeina.

**Codeine**,  $C_{17}H_{19}(CH_3)NO_3$ ,  $H_2O$ , is an alkaloid obtained from opium, in which it exists in combination with meconic acid. It is extracted along with morphine in the preparation of morphine hydrochloride, and can be separated by crystallisation after the morphine has been precipitated from the solution of the mixed hydrochlorides. The codeine thus obtained may be purified, by recrystallisation from ether. It is a methyl derivative of morphine ( $C_{17}H_{19}NO_3$ ) from which it can be artificially prepared by treatment with methyl iodide.



**Characters and Tests.**—Codeine occurs in colourless, or nearly colourless, crystals, soluble in 80 parts of water or solution of ammonia, readily soluble in alcohol or chloroform, and in dilute acids, forming salts. Melting point,  $155^{\circ}$  to  $156^{\circ}$  C. The aqueous solution has a bitter taste and an alkaline reaction. The alkaloid dissolves in an excess of concentrated sulphuric acid, forming a colourless solution, a small quantity of which, when gently warmed on a water bath with two drops of solution of ammonium molybdate or a trace of ferric chloride or potassium ferricyanide develops a blue or bluish-black colour, which, on the addition of a minute trace of nitric acid, changes to a bright scarlet, becoming orange. Heated to redness in air it leaves no ash. Moistened with nitric acid the liquid becomes yellow, but not red (distinction from morphine). A 2 per cent. solution of codeine in water, acidulated with a few drops of hydrochloric acid (with which it forms a soluble hydrochloride), gives a whitish precipitate of codeine with solution of potassium hydroxide, but not with solution of ammonia. The solubility of morphine in these alkaline solutions is just the reverse. A saturated solution of codeine in water acidulated with hydrochloric acid, should give no blue colour, but only a dull green, on the addition of solution of ferric chloride and a very dilute (and freshly made) solution of potassium ferricyanide. This test is intended to detect morphine and depends upon the reduction of ferricyanide of potassium to ferrocyanide by morphine and the consequent formation of Prussian blue. The ferricyanide solution must be dilute and freshly made, since old solution always contains ferrocyanide and hence gives a blue colour with the ferric chloride. The reduction takes place with codeine only on long standing.

[Dose.— $\frac{1}{4}$  to 2 grains.

## Codeinæ Phosphas.

**Codeine Phosphate**  $[C_{17}H_{18}(CH_3)NO_3, H_3PO_4]_2, 3H_2O$ , is the phosphate of an alkaloid obtained from opium or from morphine.

**Characters and Tests.**—Codeine phosphate forms white crystals which have a slightly bitter taste. It is soluble in four parts of water, much less soluble in 90 per cent. alcohol. A 5 per cent. solution has a slightly acid reaction, and yields a white precipitate of codeine with solution of potassium hydroxide, but not with solution of ammonia (see tests for Codeina). It loses its water of crystallisation when dried at  $100^{\circ}$  C., and at a higher temperature melts, forming a yellowish-brown liquid. It should be free from chlorides or sulphates. It should not be coloured blue by solution of ferric chloride, showing absence of morphine.

[Dose.— $\frac{1}{4}$  to 2 grains.

## Colchici Cormus.

**Colchicum Corm** is the short, fleshy, bulb-shaped, underground stem of the meadow saffron, *Colchicum autumnale*, Linné (N.O. Liliaceæ), a plant which is widely distributed over Central and Southern Europe, and abundant in moist meadows and pastures in many parts of England and Ireland. It is directed

that the corms should be collected in early summer, because they are then filled with the reserve material stored up in them by the aid of the leaves, and are believed to be in the best condition for medicinal purposes. Later, a new corm begins to form at the lateral inferior portion of each older one, and the reserve material in the latter is gradually used up as the flowers develop; the original corm shrivelling meanwhile, and ultimately decaying, so that the only trace of its existence is a rounded cicatrix upon the new corm, marking the point of attachment to its predecessor. The corms are dug up between the decay of the foliage and the appearance of the flowers, or, as the plant is then less difficult to find, soon after the flower has appeared. The fresh corms are stripped of their membranous coats and cut into transverse slices; those are dried at a temperature not exceeding  $65.5^{\circ}$  C., to avoid causing gelatinisation of the starch present, and then constitute the drug as usually seen in commerce.

**Characters.**—*Colchicum* corm, when fresh, is about 35 Mm. long and 25 Mm. broad, bluntly conical in shape, rounded on one side and flattened or hollowed on the other, where a new corm is in process of development. The outer thin brown membranous coat and inner reddish-yellow one are derived from the leaves of the plant, which have decayed prior to the collection of the corm. Internally the corm is firm, white, and solid. The juice which exudes when it is cut has a bitter taste due to the poisonous alkaloid colchicine, and is milky owing to the presence of numerous starch grains. The disagreeable odour of the juice is apparently due to a volatile body which disappears from the corm on drying. The dried slices, which are cut while the corms are fresh, and freed from the remains of the membranous coats by winnowing, are reniform or kidney-shaped in outline, from 2 to 3 Mm. thick, and their shortest diameter is from 1 to 2 Cm.: they break readily with a short fracture. When the surface is smoothed numerous fibro-vascular bundles reveal themselves as scattered darker points. The margin of each slice is slightly raised—owing to the greater shrinkage of the firm, whitish, starchy central portion in drying—and presents on its outer surface a yellowish or dull pale brown epidermis. The dried slices have the same bitter taste as the fresh corm or juice, but they are free from the disagreeable odour.

**Notes.**—The distinctive characters of fresh *colchicum* corm are its peculiar shape, bitter taste, disagreeable odour, and milky juice. When sliced and dried it loses the volatile body to which the odour appears to be due, and about 70 per cent. of water; the dried slices are characterised by their kidney-shaped outline, short starchy fracture, and bitter taste. The active principle of the drug is the poisonous alkaloid colchicine, of which, when dried, it contains 0.5 to 0.6 per cent. It has been isolated as a pale yellow amorphous substance, possessing weak basic properties. Other constituents are starch, gum, sugar, resin, tannin, and fat. Though the corm is considered to be most active about July, it is questionable whether the alkaloidal content varies to any appreciable extent with the time of collection; it is said to decrease, however, if the drug be kept for a long time before use. [Dose.—2 to 5 grains (dried).

## Colchici Semina.

**Colchicum Seeds** are obtained from *Colchicum autumnale*, Linné (N.O. Liliaceæ), being collected in the autumn when ripe, and dried. The reddish-purple flower which springs from the side of the corm has a superior ovary, which is raised to the surface of the ground as development of the flower proceeds, by elongation of the peduncle. After fertilisation the fruit forms as a three-celled capsule, which ripens during the summer, dehisces septicidally, and discloses numerous pale seeds which darken as they dry.

**Characters.**—Colchicum seeds are about 2.5 Mm. in diameter, nearly spherical in shape, but slightly pointed at the hilum, where occur the remains of a thick funiculus or stalk by which the seed has been attached to the placenta, in the fruit. The presence of minute pits on the surface makes the dull reddish-brown seeds rough. They are also very hard and tough, and must be soaked in water to enable them to be cut easily. A transverse section shows a yellowish oily endosperm, consisting of cells with thickened walls and large pits, the minute embryo being situated near the margin opposite the hilum. The seeds have no odour, but a bitter, acrid taste. Ash-yield, about 3 per cent.

**Notes.**—The distinctive characters of colchicum seeds are their rough surface, hard, horny endosperm, and the remains of the thick funiculus. Black mustard seeds are much smaller and softer; henbane seeds are kidney-shaped; grains of paradise are larger and paler, with a soft white endosperm and pungent taste. Colchicum seeds contain 6 to 8 per cent. of fixed oil, gum, starch, sugar, etc., but the chief constituent of the seeds is the poisonous alkaloid colchicine, of which they contain from 0.2 to 0.8 per cent.; other substances found in the seeds are colchicoresin,  $\beta$ -colchicoresin, and colchicein or trimethyl-acetyl-colchicinic acid, a white crystalline body, of which colchicine is understood to be the methyl ether.

## Collodium.

**Collodion** is a solution of pyroxylin in a mixture of ether and alcohol. Good samples of pyroxylin dissolve almost completely, but specimens are sometimes met with which do not form a satisfactory solution. This is probably due to improper nitration of the cotton in making the pyroxylin (compare "Pyroxylinum").

**Characters.**—Collodion is a colourless, inflammable liquid of syrupy consistence and ethereal odour. It dries quickly on exposure to air, and leaves a thin transparent film (pyroxylin unaltered except in physical form), which contracts rapidly on drying and is insoluble in water or alcohol.

**Notes.**—Collodion is used to paint on wounded surfaces in order to form a protective waterproof film. It is sometimes used as a vehicle for the application of medicinal substances, such as tannic and salicylic acids, which are soluble in the ether-alcohol. Methylated alcohol must not be used for the preparation of any medicated collodion in which iodine is an ingredient, as it causes some decomposition to take place, with the production of a very acrid odour, the cause of which has not been clearly explained.



## Collodium Flexile.

**Flexible Collodion** is ordinary collodion to which a little castor oil and Canada turpentine (so-called Canada balsam) have been added. This addition renders the film, left on evaporation of the solvent, tougher and less contractile.

## Collodium Vesicans.

**Blistering Collodion** consists of Blistering Liquid (Liquor Epispasticus) in which pyroxylin has been dissolved, so that the film left by evaporation of the solvent shall exhibit the characteristic properties of cantharides.

## Colocynthis Pulpa.

**Colocynth Pulp** is the "bitter apple" or fruit of *Citrullus Colocynthis*, Schrader (N.O. Cucurbitaceæ), freed from its rind and seeds. The plant is widely distributed throughout Northern Africa, Syria, North-Western India, Persia, etc., and is cultivated to a certain extent in Spain and Cyprus. The fruit is a gourd of the size and shape of an orange, having a smooth marbled-green surface which changes to yellow as ripening proceeds. It is three-celled when young and bears numerous seeds attached to axile placentas, which extend from the centre of the fruit nearly to the circumference. As the fruit develops, the carpellary walls disappear, and it becomes spuriously one-celled. The fleshy placentas of which the pulp chiefly consists are not juicy in the fresh state; they usually split in a radial direction throughout the greater part of their length, and appear deeply fissured in the dried fruit. The fruit is collected when ripe, freed from the thin rind by peeling with a sharp knife, and dried. Unpeeled colocynth is occasionally imported from Mogadore; the peeled fruit is imported chiefly from Smyrna, Trieste, France, Spain and, less frequently, from Persia. It is freed from seeds after arriving in this country.

**Characters and Tests.**—Colocynth fruit is usually imported peeled, occurring in more or less broken balls—about 5 Cm. or less in diameter, and very light in weight—the outer surface of which is formed by part of the thin whitish mesocarp, the seeds and fleshy placentas being visible at points where the mesocarp has been removed. On cutting a fruit transversely the placentas are generally exhibited as radiating fissures dividing the fruit into three parts. In each part, near the periphery, half of each placenta curves inwards and bears on its inner margin several vertical rows of seeds. The flattened ovoid seeds, which number from two to three hundred in each fruit, are yellowish-white to dark-brown in colour, according to the degree of ripeness. The pulp, which alone should be used for medicinal purposes, constitutes about one-fourth the weight of the peeled fruit, and consists chiefly of the placentas; it is very light, spongy, whitish, and pith-like, with a very slight odour, but an intensely bitter taste. As colocynth fruit contains no starch, the powdered pulp should not yield the characteristic reactions with the tests for that substance. Neither should the powder yield more than traces of fixed oil to ether, thus showing

that the seeds have been entirely removed. The seeds contain 15 to 17 per cent. of fixed oil, whereas the pulp alone does not yield to ether more than 3 to 5 per cent. of extractive of an oily nature. It is officially stated that when dried at 100° C. and incinerated the pulp should yield not less than 9 per cent. of ash, that proportion being supposed to indicate the absence of seeds.

**Notes.**—Colocynth pulp is distinguished by its light weight and intensely bitter taste. Turkey colocynth, imported from the Levant, is the finest, and Spanish comes next in value; the poorest is Persian, which is only occasionally seen on the market. The bitter principle of colocynth is an amorphous yellow glucoside, colocynthin, which is found in the pulp to the extent of about 0.6 per cent., but not in the seeds; it has not been fully investigated, but appears to be easily hydrolysed by dilute acids or alkalis, yielding resinous colocynthein and sugar. The pulp also contains a colourless crystalline body named colocynthetin, and from 1 to 1.3 per cent. of fixed oil. The seeds contain but little of the bitter principle, but from 15 to 17 per cent. of fixed oil and 6 per cent. of albuminoids. The ash of colocynth may vary from 4 to nearly 6 per cent. in the entire fruit as imported. But whilst the pulp yields from 7 to 13 per cent. of ash, the seeds yield only from 2.5 to 3 per cent., the proportion being greatest in the case of unripe seeds.

## Confectiones.

**Confections** are preparations which were formerly much more widely used in medicine than they are at the present time. They are essentially preparations made by combining drugs in powder with syrup or honey to a stiff consistence, the sweet vehicle serving the double purpose of masking the flavour of the associated medicament and obviating the difficulty of administering bulky powders. They are intended to be swallowed without further preparation. The diminished use of confections in medical treatment may, in the case of vegetable drugs, be traced to the increasing use of active principles or comparatively concentrated preparations like the extracts in place of the whole drug in the form of powder. This follows naturally from an increased knowledge of the active principles of drugs which renders superfluous the ingestion of inert vegetable tissue. The introduction of more convenient methods of administration such as are afforded by compressed tablets, cachets and capsules have also contributed to the same result. There are now only four official formulæ for confections in the Pharmacopœia and of those one is used only as a pill excipient.

### **Confectio Piperis.** CONFECTION OF PEPPER.

A mixture of black pepper, caraway fruit, and honey.

[Dose.—60 to 120 grains.

### **Confectio Rosæ Gallicæ.** CONFECTION OF ROSES.

A pulped mixture of fresh red rose petals and refined sugar, used as a pill excipient.

### **Confectio Sennæ.** CONFECTION OF SENNA.

Made by boiling figs and prunes with water, adding tamarinds and cassia pulp and rubbing the softened fruits through a sieve. In this pulp sugar

and extract of liquorice are dissolved by the aid of gentle heat and then senna leaves and coriander fruits, both in fine powder, are incorporated. [Dose.—60 to 120 grains.

### Confectio Sulphuris. CONFECTION OF SULPHUR.

A mixture of sublimed sulphur and acid tartrate of potassium with syrup and glycerin. Tincture of orange is added to flavour it and a little powdered tragacanth to give sufficient viscosity to the preparation, so that the solids do not settle too rapidly. The presence of the glycerin prevents the confection from becoming dry. [Dose.—60 to 120 grains.

## Conii Folia.

**Conium Leaves** are obtained from the spotted hemlock, *Conium maculatum*, Linné (N.O. Umbelliferæ), the fresh leaves, with the branches to which they are attached, being collected when the fruit begins to form. The plant is cultivated for medicinal purposes, but wild specimens are also collected and used.

**Characters and Test.**—Conium leaves are more or less divided in a pinnate manner, dark green on the upper surface, paler on the under surface, quite glabrous, and attached to the stem by amplexicaul or clasping petioles of varying length, those of the lower leaves being hollow. The lower leaves are decompound, and sometimes nearly 70 Cm. in length, but the upper ones are less divided, and smaller; the ultimate ovate or lanceolate segments or divisions of all the leaves terminate in smooth, colourless, horny points. The stem is smooth, hollow, and marked on its lower part with dark purple spots which tend to disappear on drying. The inflorescence of hemlock is an umbel, with about twelve rays and both general and partial involucre, the latter consisting of three short lanceolate bracts directed outwards. The broadly ovoid fruits have irregular crenate ridges and a grooved endosperm. The plant has a bitter taste and a strong disagreeable odour, which is more pronounced—recalling that of mice—when the plant is crushed and rubbed with solution of potassium hydroxide.

**Notes.**—The distinctive characters of hemlock are the smooth spotted hollow stem, the much divided glabrous leaves with their ultimate divisions terminating in smooth colourless points, the presence of both general and partial involucre, the crenate ridges and grooved endosperm of the fruit. In Fool's Parsley, *Æthusa cynapium*, the ultimate divisions of the leaves terminate in short brownish points, the umbel has no general involucre, and the bracts of the partial involucre are long and narrow; in Wild Chervil, *Anthriscus sylvestris*, the leaves are hairy, the partial involucre is not directed outwards, and the fruit is elongated. The chief constituents of hemlock are the alkaloids coniine and conhydrine, which are present in largest proportion when the plant is in full bloom, the stem then containing about 0.064 per cent. of alkaloid, the leaves 0.187 per cent., and the flowers and flower stalks 0.236 per cent. Other substances found in the plant are  $\gamma$ -coniceine, methyl-coniine, pseudo-



conhydrine, volatile oil, albumin, mucilage, etc. Coniine is  $\alpha$ -normal-propyl-piperidine; it is a colourless, oily, volatile liquid, of disagreeable mouse-like odour, has an acrid taste and possesses poisonous properties. Conhydrine or oxy-coniine, which is less poisonous, occurs in glittering plates or scales, and yields coniceine on heating with phosphoric anhydride. Methyl-coniine resembles coniine, but is of minor importance. Pseudo-conhydrine is an isomer of conhydrine. Synthetic coniine contains isoconiine.

## Conii Fructus.

**Conium Fruit** is collected from *Conium maculatum*, Linné (N.O. Umbelliferae), when full-grown but while yet unripe, *i.e.*, before the colour has changed from green to yellow. It is then dried and carefully preserved.

**Characters and Test.**—Conium fruit is broadly ovoid in shape, greenish grey in colour, about 3 Mm. in length and breadth, slightly compressed laterally, and crowned by the small depressed stylopod bearing the remains of the stigmas. The two glabrous mericarps of which the fruit consists are usually separated in the drug as met with in commerce; each one possesses five irregular, more or less crenate or wavy primary ridges, which are paler than the rest of the mericarp and sharply prominent. When a mericarp is cut transversely and examined with a lens, the endosperm is seen to be deeply grooved on the commissural surface, and no vittæ are visible. The fruit has no marked taste or odour, but a strong disagreeable odour, recalling that of mice, is produced on rubbing it with potassium hydroxide solution.

**Notes.**—The distinctive characters of conium fruit are the glabrous surface, irregular crenate ridges, grooved endosperm, absence of vittæ, and the mouse-like odour given off on rubbing with potassium hydroxide solution. Anise fruit, which somewhat resembles it, has short bristly hairs, numerous vittæ, and an ungrooved endosperm, which is nearly flat on the commissural surface; the fruit of Fool's Parsley also has vittæ, besides differing considerably in shape from that of conium. The chief constituent of conium fruit is the poisonous, volatile, liquid alkaloid coniine, of which it may contain 2.77 per cent., but commercial fruits yield only 0.5 to 1.3 per cent.; as the fruit ripens the proportion of coniine diminishes rapidly. Other constituents are methyl-coniine—an oily liquid resembling coniine, conhydrine, pseudo-conhydrine, and  $\gamma$ -coniceine. The production of the mouse-like odour on rubbing the fruit with potassium hydroxide solution is due to the liberation of coniine from the combinations with vegetable acids in which it occurs naturally.

## Copaiba.

**Copaiba, or Copaiva**, is an oleo-resin obtained from the trunk of *Copaifera Lansdorfii*, Desfontaines (N.O. Leguminosæ), and other species of *Copaifera*, Linné. The trees yielding it are indigenous to Brazil, Venezuela, New Granada, and other parts of Central and South America. The oleo-resin is

contained in anastomosing, schizogenous secretion ducts, which form an extensive network in each zone of the secondary wood of both stem and root, resembling in arrangement the laticiferous tissue of the dandelion. Lysigenous cavities are also found; they appear to be formed by the breaking down of cell walls, which are probably transformed into resinous or oleo-resinous substances. The oleo-resin is collected in cavities cut in the trunk of the tree near the base, and as much as 48 litres is stated to have been obtained from a single tree. The commercial varieties of the drug are named after the ports—Maracaibo, Para, Maranham, Savanilla, Angostura, etc.—whence they are shipped, Maracaibo copaiba being supposed to be most efficacious.

**Characters and Tests.**—Copaiba is a more or less viscid liquid, generally transparent, but sometimes opalescent and occasionally slightly fluorescent. It has a characteristic aromatic odour, a persistent acrid, somewhat bitter taste, and a colour varying from light yellow to pale golden brown. The specific gravity of the oleo-resin varies from 0.916 to 0.993, according to the proportion of volatile oil it contains; when kept it becomes thicker by resinification of the volatile oil and the specific gravity increases. The proportion of volatile oil should not be less than 40 per cent. The oil should not boil under 250° C.; its specific gravity is from 0.900 to 0.910 and, it is officially stated, should rotate the plane of a ray of polarised light from 28° to 34° to the left, thus indicating the absence of African copaiba, the oil from which is dextrorotatory. The actual rotation of the oil, however, ranges from  $-7^{\circ}$  to  $-35^{\circ}$ . Pure copaiba is entirely soluble in absolute alcohol, ether, benzene, carbon bisulphide, fixed and volatile oils; also in two parts of glacial acetic acid, and four of petroleum spirit, only a filmy deposit being yielded by the latter solution on standing. When heated until all volatile oil is removed and then cooled, copaiba yields a hard residue which is easily reduced to powder, thus indicating absence of castor oil and other fixed oils. No odour of turpentine should be given off by the oil volatilised during the operation. The presence of turpentine (boiling point about 160° C.) also lowers the boiling point of the oil. If gurjun oil or “balsam” be present, a transient violet colour will be produced on dissolving 2 drops of the impure copaiba in 20 parts of carbon bisulphide, and adding 1 drop of a cooled mixture of equal parts of nitric and sulphuric acids, but a similar coloration is stated to have occasionally been yielded by a genuine copaiba. Another test for the presence of gurjun oil is the reddish or purple colour produced on carefully adding 4 drops of the impure copaiba to a mixture of 15 C.c. of glacial acetic acid and 4 drops of nitric acid. If a hydrocarbon oil be present as an adulterant, it will form a separate layer at the bottom of a test tube on warming therein 1 C.c. of copaiba with 4 C.c. of 95 per cent. alcohol.

**Notes.**—Though frequently termed a “balsam,” copaiba cannot properly be so regarded, inasmuch as it contains neither cinnamic nor benzoic acid.\* Neither does gurjun “balsam,” or wood oil—an oleo-resin obtained from *Dipterocarpus turbinatus*, Gaertner (N.O. Dipterocarpeæ), which has been used to adulterate copaiba. It somewhat resembles copaiba in odour and taste, but is usually of a dark-red colour and fluorescent. Para copaiba is a thin yellowish liquid; the

Maracaibo variety is viscid as treacle and brownish-yellow in colour. Resin and volatile oil are the chief constituents of the drug, the proportion of the latter varying from 20 to 80 per cent., though it is usually between 40 and 60 per cent. The resin of Maracaibo copaiba contains copaivic and  $\beta$ -metacopaivic acids, two indifferent copaibo-resenes, and crystalline illurinic acid; the resin of Para copaiba contains paracopaivic and homoparacopaivic acids, and two resenes. The volatile oil (specific gravity 0.900 to 0.910) consists chiefly of a sesquiterpene, and is alike in the two varieties. A bitter principle, which is also present in small quantity in the oleo-resin, can be removed by boiling the drug with water, and a fluorescent substance is also present.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

## Coriandri Fructus.

**Coriander Fruit** is the product of *Coriandrum sativum*, Linné (N.O. Umbelliferæ), an erect herbaceous annual which has been naturalised throughout temperate Europe and is cultivated in Russia, Thuringia, Northern Africa, Malta and India. The fruit is collected when ripe and dried.

**Characters.**—Coriander fruit is a cremocarp, of nearly globular shape, the two mericarps of which it consists being firmly united by their margins and enclosing between them a small cavity. The fruit is about 5 Mm. in diameter, brownish-yellow in colour, and quite glabrous. The two mericarps—each of which bears five inconspicuous wavy primary ridges, containing fibro-vascular bundles and alternating with four prominent straight secondary ridges—are crowned by the remains of the calyx teeth and styles. A transverse section exhibits two vittæ on the commissural or inner surface of each mericarp, and both transverse and radial sections show a curved endosperm. The agreeable taste and the aromatic odour, which is more marked when the fruit is bruised, are due to the volatile oil present.

**Notes.**—The distinctive characters of coriander fruit are its nearly globular shape, the firmly united mericarps, wavy primary and straight secondary ridges and the presence of two vittæ on each commissural surface. Indian coriander fruit is ovoid instead of globular in shape. Unripe coriander fruit and oil distilled therefrom have a disagreeable fetid odour, which disappears from the fruit as it ripens, and from the oil on keeping. The fruit contains fat, mucilage, and volatile oil, which consists almost entirely of d-linalool (coriandrol) and is present in the ripe fruit to the extent of 0.8 to 1 per cent.

## Creosotum.

**Creosote** is a mixture of guaiacol, creosol, and other phenols obtained from the tar produced by the destructive distillation of wood. It is obtained from the portion of wood-tar heavier than water, by treatment with sodium hydroxide solution, which dissolves the numerous varieties of phenols, *i.e.*, hydroxy aromatic derivatives, occurring in the tar, forming the soluble sodium derivatives known as phenates. The alkaline solution is filtered to remove the insoluble hydrocarbons, etc., and the phenols liberated by addition of sulphuric



acid to the filtrate. Those phenols which are easily soluble in water remain in the aqueous liquor, while the less soluble ones are deposited as an oily layer. This oily layer is separated and fractionally distilled, and the portion distilling between  $200^{\circ}$  and  $220^{\circ}$  C. constitutes the mixture of substances known as creosote; it should consist chiefly of guaiacol.

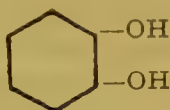
**Characters and Tests.**—Creosote is a colourless or yellowish, highly refractive liquid, which darkens on keeping, having a strong empyreumatic odour and acrid taste; neutral or only faintly acid to litmus. It is dissolved by about 150 parts of water at ordinary temperatures, and is more soluble in hot water. It is freely soluble in 90 per cent. alcohol, ether, chloroform, and glacial acetic acid. Its specific gravity should not be below 1.079. It should distil between  $200^{\circ}$  and  $220^{\circ}$  C. A one per cent. solution in alcohol or a half per cent. solution in water, with a drop of ferric chloride solution, yields a green coloration, rapidly changing to a reddish-brown. It is stated to rotate the plane of a ray of polarised light slightly to the right. Dropped on white filtering paper and exposed to a temperature of  $100^{\circ}$  C., it leaves no translucent stain, showing that it has been rectified by fractional distillation, and contains no substances of high boiling point, such as are not easily volatilised under the conditions mentioned. It is miscible with an equal volume of collodion without gelatinisation, while carbolic acid under these circumstances gelatinises. When shaken with five times its bulk of solution of ammonia in a graduated cylinder, its volume should not be materially decreased: carbolic acid if present will dissolve in ammonia and produce a corresponding decrease of volume.

**Notes.**—Guaiacol predominates in some specimens of creosote and creosol in others, beechwood creosote containing most guaiacol. Rhenish beech tar creosote is stated to contain guaiacol, creosol, phlorol, phenol and cresols. Beechwood creosote dissolves in about 110 parts of water, and mixes in all proportions with absolute alcohol, 90 per cent. alcohol, ether, glacial acetic acid, chloroform, benzene, or petroleum spirit; it also mixes freely with glycerin up to 3 parts of the latter, but a further addition of glycerin renders the mixture turbid. Guaiacol is soluble in 80 parts of water, and mixes with glycerin in all proportions; creosol is soluble in 150 parts of water, but will not form a clear mixture with glycerin in any proportion. Neither pure guaiacol nor creosol has any measurable effect upon polarised light, nor have most commercial samples of genuine wood tar creosote. It should be noted that the phenols obtained from wood tar are for the most part methoxy derivatives, *i.e.*, they contain the methoxy group— $\text{O}\cdot\text{CH}_3$ , linked to the benzene nucleus, while the coal tar phenols are simple phenols. The aqueous layer in the distillate obtained by the destructive distillation of wood contains, as is well known, considerable quantities of methyl alcohol. This indicates that the action of heat upon the organic substances in wood is very prolific in the production of methyl derivatives as compared to the action of heat upon coal. The two chief constituents of good creosote are guaiacol and creosol. The former is the methyl ether of pyrocatechin and is called guaiacol because it was first obtained by the destructive distillation of guaiacum. Pyrocatechin is the ortho variety of the

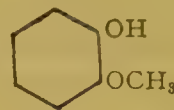
three isomeric di-hydroxy-benzenes, *i.e.*, it contains the two hydroxyl groups linked to adjacent carbon atoms in the nucleus.



Benzene.

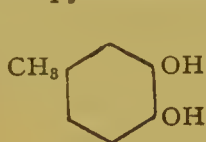


Pyrocatechin.

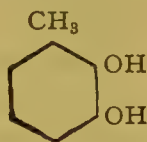


Guaiacol.

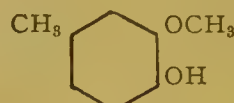
Creosol is the corresponding derivative of one of the two possible homologues of pyrocatechin—



(1)



(2)



Creosol.

It is the methyl ether of the methyl-pyrocatechin shown by formula (1), and may be distinguished as methyl-1-meth-oxy-3-oxy-4-benzene. The figures placed after the prefixes in this systematic name indicate the relative position of the substituting groups in the benzene ring. In addition to these two bodies methyl ethers of trihydric phenols and also simple phenols occur in small quantities in creosote. Guaiacol boils at  $200^{\circ}$  C. and creosol at  $221^{\circ}$  C., hence the fraction collected between  $200^{\circ}$  and  $220^{\circ}$  will naturally contain these two bodies in abundance. The distillation test and the determination of specific gravity taken together give good indications of the quality of a sample of creosote. Distinguish carefully between creosol and cresol. Cresol is a monohydric phenol—hydroxy toluene  $C_6H_4(CH_3)(OH)$ , the next higher homologue of ordinary phenol (carbolic acid). The methyl ethers differ from simple phenols in being less soluble in water, and also less caustic and poisonous. The green colour produced on adding ferric chloride to a dilute solution of creosote is characteristic of ortho-oxy derivatives of benzene. Compare the colour given by ferric chloride with resorcin and hydroquinone.

[Dose.—1 to 5 minims.]

## Creta Præparata.

**Prepared Chalk** is native calcium carbonate freed from most of its impurities by elutriation.

**Characters and Tests.**—Prepared chalk occurs in white friable masses or a white powder yielding the reactions of calcium and of carbonates. It should contain only traces of iron, aluminium, magnesium, phosphates, sulphates, or silica. Dissolved in diluted acetic acid, the solution should yield no precipitate with solution of potassium chromate—barium carbonate, if present, will also dissolve, forming barium acetate, and this will give a yellow precipitate of the sparingly soluble barium chromate. [Dose.—10 to 60 grains.]

## Crocus.

**Saffron** consists of the dried stigmas and tops of the styles of *Crocus sativus*, Linné (N.O. Irideæ), a plant which is cultivated in Spain, France, Austria, and Italy, and was formerly cultivated in England, near Saffron Walden. The flower produced by the plant is of a pale, purplish-violet colour, and has a long,

pale-yellow style which terminates in three deep-red, elongated, protruding and pendulous stigmas. After the flowers have been collected, the stigmas and upper part of the style are separated from each and dried, the resulting product being the hay saffron of commerce. The greater part of the drug is produced in Spain, being chiefly exported from Valencia and Alicante, whence the two most important commercial varieties take their names; the different qualities vary in the size of the stigmas, in relative freedom from useless parts of the flower such as the stamens, and from fraudulently added inorganic substances. Valencia saffron is much superior to the Alicante variety.

**Characters and Tests.**—Saffron of good quality occurs in entire portions about 25 Mm. or more in length, consisting of single orange-red or reddish-brown stigmas, or three such attached to the top of a yellow style; they are thickened and tubular above, each having a slit on the inner side near the upper extremity and its mouth being jagged or irregularly notched. Unless quite dry, the loosely matted mass of stigmas is flexible and unctuous to the touch; it has a strong, peculiar, aromatic odour, due to the presence of volatile oil, and a bitter somewhat aromatic taste, due to the volatile oil and a colourless bitter principle named picrocrocin. If thrown on the surface of water, the dry stigmas expand and their shape is clearly revealed; the liquid surrounding them assumes a deep yellow colour, owing to the extraction of the soluble colouring matter. Saffron should impart an intense orange-yellow tint to a wet finger on which it is rubbed, thus showing that the colouring matter has not been extracted, and it should leave no oily stain when pressed between folds of white filter paper, thus proving freedom from added vegetable or mineral oil. Warm water in which saffron is soaked should be coloured orange-yellow, the saffron itself becoming paler and not depositing any white or coloured powder. If the water be coloured red or pink and the saffron yields colour freely to ether or petroleum spirit, it has probably been exhausted and afterwards artificially coloured with aniline dyes, logwood, Brazil wood, or the yellow or orange salts of dinitrocresylic acid. Any white or coloured powder which may be deposited will probably consist of calcium carbonate, barium sulphate, bole, or other inorganic impurity with which the saffron has been dusted after being damped with glycerin, honey, or glucose and water. Absence of added water should be indicated by the saffron losing not more than 12.5 per cent. of moisture when dried at 100° C. The dried saffron should not deflagrate when incinerated with free access of air, nor should it yield more than about 7 per cent. of ash, the first test indicating absence of nitrates and the second of other fraudulently added inorganic matter. The presence of glycerin or other substances which are soluble in water and leave no ash when incinerated will be indicated by the proportion of water-soluble substances yielded by the drug exceeding 15 per cent.

**Notes.**—The stamens, or portions of the perianth, of saffron and other flowers have been used to adulterate the drug, as well as the florets of safflower and calendula, arnica flowers, the slender stems and roots of monocotyledonous plants, etc. All such adulterants may be detected by allowing the drug to expand in water and noting the shape of the pieces. Saffron contains about 1 per cent. of an odorous volatile oil—its chief active constituent, a colourless,



crystalline, bitter principle, named picrocrocin, and an amorphous reddish-orange, glucosidal colouring matter named crocin or polychroit, the colour of which is changed to deep blue by concentrated sulphuric acid, and to green by nitric acid. Crocin is closely related to carotin, and yields on hydrolysis volatile oil, sugar, and a second red colouring matter named crocetin. Similarly, picrocrocin yields on hydrolysis volatile oil and a reducing sugar named crocose. In addition to the terpene of which it chiefly consists, the volatile oil of saffron—which has a hot, acrid, bitter taste—is said to contain an oxygenated compound,  $C_{10}H_{18}O$ , together with small quantities of pinene and cineol. The small proportion of volatile oil present in the drug can be increased by suitable treatment, since the terpene of which it chiefly consists can be formed by the hydrolysis of picrocrocin, as previously stated, thus—



Cake saffron, so-called, consists usually of safflower florets made into cakes with sugar and some adhesive substance.

## Cubebæ Fructus.

**Cubebs**, or “tailed pepper,” consists of the dried unripe fruit of *Piper Cubeba*, Linné (N.O. Piperaceæ), a dioecious woody climber which is indigenous to, and probably cultivated in, Java, Sumatra, and Borneo. The pistillate inflorescence of the plant is a spike of sessile flowers; as the young sessile fruits mature, they become elevated on slender stalks produced by abnormal development of the pericarp at its base. When full-grown, but whilst still green and unripe, the fruit is stripped from the rachis, dried in the sun, and exported from Batavia or Singapore to Amsterdam and London.

**Characters and Tests.**—Cubebs are nearly globular fruits, each containing a single seed attached by the base, and bearing the minute remains of three or four stigmas at the apex; they are about 4 Mm. in diameter, and greyish-brown or nearly black in colour. If depressed at the base, the fruits are immature. Owing to shrinkage during the drying of the fruit, the thin, brittle pericarp is reticulately wrinkled. At the base, the pericarp is abruptly prolonged into a slender, rounded or slightly flattened stalk about 6 Mm. in length. The fully developed seed is reddish-brown in colour, with a very small embryo embedded near the apex in a somewhat scanty endosperm surrounded by a copious perisperm. Frequently a fruit contains only the dark shrunken remains of a partially developed seed. The characteristic strong and aromatic odour of cubebs, due to the volatile oil present, is more marked when the fruit is crushed; the taste of the drug is also warm, aromatic, and somewhat bitter, the bitterness being due to the cubebin present. Cubebs have two layers of much thickened and lignified parenchymatous cells in the pericarp, as may be seen in a transverse section, one layer being near the epidermis, the other constituting the smooth, hard, inner surface or endocarp, and consisting of radially elongated cells. The presence of those two layers, which can only be detected under the microscope, helps to

distinguish cubebs from fruits of similar appearance. The crushed fruit imparts a crimson colour to sulphuric acid; most of the substitutes for cubebs yield only a brownish-red colour under similar conditions. Ash-yield, about 6 per cent.

**Notes.**—The distinctive characters of cubebs are the slender and not easily detachable stalk, the attachment of the seed to the pericarp by the base only, the characteristic odour and taste, the microscopical characters, and the reaction with sulphuric acid. Portions of the rachis on which the fruit is borne may be found mixed with cubebs, and many fruits of similar appearance have been used to adulterate the drug, but none possess the same microscopical characters, whilst also yielding the distinctive crimson colour with sulphuric acid. Cubebs contain from 10 to 18 per cent. of a volatile oil, consisting chiefly of cadinene; the oil occurs in cells in the pericarp and perisperm, and about 1.7 per cent. can also be obtained from the rachis, which contains similar oil cells, as well as the stem, leaves, etc. Other constituents of cubebs are fat, wax, starch, cubebin—a colourless, crystalline substance which gives a cherry-red colour with sulphuric acid, an acid resin named cubebic acid, and an indifferent resin. Cubebic acid is a white amorphous substance which gives a crimson colour with sulphuric acid.

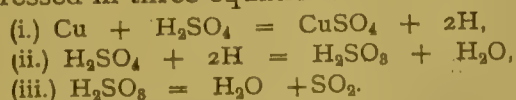
[Dose.—30 to 60 grains.

## Cupri Sulphas.

**Copper Sulphate**,  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ , may be obtained by the action of sulphuric acid on cupric oxide or copper. In making the sulphate from the oxide dilute sulphuric acid is employed—



When the metal is employed as the immediate source of the sulphate concentrated sulphuric acid must be employed, because the diluted acid has no action on copper. Even with concentrated sulphuric acid no considerable action occurs unless the mixture be heated, and then the copper displaces hydrogen from the acid and forms the sulphate. The hydrogen is not, however, evolved (as in the case of zinc and cold dilute sulphuric acid), because under the conditions of the operations—*i.e.*, its liberation in presence of hot concentrated sulphuric acid—it reduces the sulphuric acid to sulphurous acid, and the latter then decomposes into sulphurous anhydride and water. By the action of hot concentrated sulphuric acid on copper, therefore, a solution of copper sulphate is obtained, while sulphurous anhydride (sulphur dioxide) is evolved. The reaction may be expressed in three equations—



The reduction of the sulphuric acid may, under certain conditions, even result in the production of hydrogen sulphide—



and then the hydrogen sulphide will react with some of the previously-formed copper sulphate, producing a black precipitate of copper sulphide—



**Characters and Tests.**—Copper sulphate forms blue triclinic prisms, soluble in 3.5 parts of cold water, forming a solution which strongly reddens litmus; very soluble also in glycerin, almost insoluble in 90 per cent. alcohol (all ordinary metallic sulphates, except ferric sulphate, are practically insoluble in strong alcohol). It affords the reactions characteristic of copper and of sulphates. It should be free from lead, arsenium, zinc, or aluminium, and contain only traces of iron.

**Notes.**—The acid reaction of the aqueous solution of copper sulphate is worthy of note, although the salt is neutral in composition. This behaviour is shown by other salts, *e.g.*, alum, which, like  $\text{CuSO}_4$ , contains a weak base and a strong acid radical. The reverse behaviour to litmus is shown by salts like potassium acetate, which contain a strong base and a weak acid radical. In both cases the addition of very little free alkali or acid respectively suffices to overcome the acid or alkaline reaction of the solutions, which is due to the partial hydrolysis of the dissolved salt by the water. The salts of copper corresponding to the black oxide,  $\text{CuO}$ , are known as cupric salts, because copper forms another series of salts corresponding to a lower oxide, the red cuprous oxide. The latter salts are mostly unstable, and pass readily into cupric salts. Cuprous oxide (the red precipitate obtained by the reduction of Fehling's solution) and cuprous iodide (upon the production of which a method of separating iodides from bromides and chlorides is founded) being the best known representatives of the cuprous salts. In commerce, a crude copper sulphate, known as "blue vitriol," is sold for the purpose of wheat dressing. This is made by roasting pyrites, which contains copper sulphide and sulphides of other metals, chiefly iron. By roasting and exposure to air the sulphides are converted into sulphates and removed by lixiviation. Such "blue vitriol" always contain more or less iron sulphate, which cannot easily be separated from copper sulphate by recrystallisation since it is isomorphous with it. Note that this isomorphism occurs, although the two sulphates contain different quantities of water of crystallisation. [*Dose.*— $\frac{1}{4}$  to 2 grains (astringent); 5 to 10 grains (emetic).

### Cuspariæ Cortex.

**Cusparia Bark** is obtained from *Galipea officinalis*, Hancock (N.O. Rutaceæ), a tree indigenous to the mountains of Venezuela, and not, as officially stated, from *Cusparia febrifuga*, De Candolle. The dried bark was originally brought to Trinidad, whence it is exported to Europe, from Angostura, on the Orinoco. Hence the name "Angostura bark" which is sometimes applied to it. The bark is not very easily detached from the tree, its close adherence to the wood being indicated by the rough, slightly exfoliating inner surface, and by the fact that strips of wood are occasionally found attached to the bark.

**Characters.**—Cusparia bark occurs in quills or in somewhat thin flattened or curved pieces, with an obliquely cut edge, from 10 to 12 Cm. or more in length, 25 Mm. wide, and 2 Mm. thick. The outer corky layer of the bark is grey or yellowish, being soft and friable in the latter case, easily removed by the finger-nail, and then revealing a dark-drown resinous under-surface; when



the cork is greyish, however, it is thin and firmly adherent, the difference being due to the production of alternate layers of thin and thick walled cork cells. In either case, a hard dark-brown cortex comes next to the cork, and the inner surface of the bark consists of light cinnamon or chocolate-brown bast. The latter is finely striated, frequently exhibits a laminated structure, and has numerous short, white, longitudinally arranged lines, which are clearly visible under a lens after the surface has been smoothed with a knife. The lines are formed by axially elongated cells filled with acicular crystals of calcium oxalate, white masses of which can also be seen in smoothed radial or transverse sections. The bark breaks with a short resinous fracture, the calcium oxalate appearing on the fractured surface as white points. A transverse section of the bark exhibits the grey or buff-coloured cork with the adjoining yellowish-brown cortex, and next to that the bast, in which yellowish oblique or wavy medullary rays alternate with darker bast rays. The cells containing calcium oxalate occur throughout both cortex and bast, as well as minute dark cells or glands filled with oil. Usually no sclerenchymatous tissue is present other than small isolated groups of bast fibres, the bark being thus distinguished from others which resemble it. The musty odour of cusparia is due to the volatile oil it contains, and its bitter taste chiefly to angosturin.

**Notes.**—The distinctive characters of cusparia bark are the frequently spongy cork, the laminated inner surface, the peculiar odour, and the presence of calcium oxalate. The bitterness of cusparia bark is chiefly due to a colourless bitter principle named angosturin, which is soluble in water or alcohol, but the bark also contains about 2·4 per cent. of bitter, crystalline alkaloids—galipine, cusparine, galipidine, cusparidine, and cuspareine, together with certain amorphous alkaloids; volatile oil is present in the proportion of about 1·5 per cent., together with resin, gum, and a glucoside which yields a fluorescent substance when boiled with diluted sulphuric acid.

## Cusso.

**Kousso** consists of the dried panicles of pistillate flowers of *Brayera anthelmintica*, Kunth (N.O. Rosaceæ), a tree which is a native of North-Eastern Africa and cultivated in Abyssinia, whence the drug is exported. The long panicles of pistillate flowers are collected after fertilisation, dried, and packed into cylindrical rolls or "hanks," which are bound round with the flexible stem of a monocotyledonous plant. The dried flowers stripped from the panicles are sometimes imported and offered as "loose kousso." The staminate flowers are also collected, but are not official.

**Characters.**—Kousso usually occurs in more or less cylindrical rolls from 3 to 6 Dcm. in length, composed of the dull reddish panicles of pistillate flowers. The stout main axis is covered with shaggy brown hairs and branches repeatedly, the branches arising from the axils of large sheathing bracts and being more or less covered with brownish or greyish hairs and glands, the latter appearing under a lens as a brownish powder adhering to the surface. The numerous small flowers have short stalks, and are mostly unisexual, with two roundish membranous veined bracts at the base of each. The pistillate flowers

bear a caducous white corolla and abortive stamens, but no trace of either can be found in the drug; they are also distinguished by two monocarpellary ovaries enclosed in the tube of the calyx. The calyx itself consists of two alternating whorls of five segments each, the conspicuous outer sepals being reddish-veined and externally hairy, whilst those constituting the inner whorl are curved inwards over the young fruit and shrivelled. The drug has a slight tea-like odour, and a bitter acrid taste. Ash-yield, about 5 per cent.

**Notes.**—The distinctive characters of kousso are its reddish colour, the enlarged reddish-veined outer sepals, and the inner sepals curved over the immature fruit. Those characters serve to distinguish the pistillate from the greenish staminate flowers, which are not official. The latter are often unexpanded; they are said to be much less active than the pistillate flowers, their small outer sepals are densely covered with short hairs, and their stamens are fertile. Loose kousso, which is also excluded by the official description, frequently contains a considerable admixture of staminate flowers. The active principle of kousso appears to be kosotoxin, a yellow amorphous substance, which is a strong muscle poison; other constituents are the inactive crystalline substances protokosin and kosidin, a yellowish bitter acrid resin, a tasteless resin, and tannin. Two inactive, pale yellow, crystalline substances, named  $\alpha$ -kosin and  $\beta$ -kosin, are probably not natural constituents of the drug, but derivatives of kosotoxin.

## Decocta.

**Decoctions** are preparations made by exposing drugs to the action of water maintained in a state of ebullition. The resulting fluids resemble the infusions in so far as their composition is determined by the selective solvent action of the same menstrum, water. As the temperature of the water is, in the case of decoctions, maintained at the boiling point we may expect the extraction of soluble matters to be more complete than in the case of infusions, but since volatile substances will be dissipated by the ebullition, the process of decoction cannot be suitably applied to those drugs which contain aromatic principles. In the absence of volatile constituents it is suitably applied to drugs of a hard woody texture which do not easily yield their virtues to water by simple maceration in that fluid. In making decoctions it is usual to bring the volume of the finished product to some definite measure by the addition of water which is poured over the contents of the strainer, otherwise they will be liable to vary in concentration owing to the variation in the quantity of menstrum evaporated during ebullition under varying conditions. There are now only three official decoctions, but the number has been much greater in former editions of the Pharmacopœia.

### **Decoctum Aloes Compositum.** COMPOUND DECOCTION OF ALOES.

Made by boiling extract of Barbados aloes and myrrh with potassium carbonate (which aids the solution of the resinous constituents of the two drugs), extract of liquorice, and distilled water. After boiling, saffron is added, and when cold, tincture of cardamoms; after standing

two hours the liquid is strained and brought to the required volume by the addition of distilled water. The saffron is added after boiling so that its colour and aroma may not be depreciated thereby, while the tincture is added to the cold liquid so that its alcohol may not be unnecessarily dissipated. For it is added, not only as a carminative, but as a preservative, and this preservative action depends upon the alcohol which inhibits the growth and development of moulds and other organisms which gain access to the fluid. The decoction contains one part of extract of aloes in 100 fluid parts. [*Dose*.— $\frac{1}{2}$  to 2 fluid ounces.

**Decoction Granati Corticis.** DECOCTION OF POMEGRANATE BARK.

Made by boiling 4 parts of bark, in No. 10 powder, with 24 fluid parts of water for ten minutes, straining, and making up the strained product to one pint by the addition of water. [*Dose*.— $\frac{1}{2}$  to 2 fluid ounces.

**Decoction Hæmatoxyli.** DECOCTION OF LOGWOOD.

Made by boiling 1 part of the logwood chips with 24 fluid parts of water for 10 minutes, adding a little cinnamon bark towards the end of the operation. The strained liquid is brought to the volume of one pint by the addition of water. [*Dose*.— $\frac{1}{2}$  to 2 fluid ounces.

## Digitalis Folia.

**Digitalis** or **Foxglove Leaves** are the product of *Digitalis purpurea*, Linné (N.O. Scrophularinæ), a biennial herb which is widely distributed throughout Europe and common in England, where it occurs both wild and cultivated. The plant produces a rosette of leaves during the first year of its growth, but the flowering does not occur until the second year, and it is directed that the leaves are to be collected when the plant commences to flower, as they are considered to be most active then, and the presence of the flower also prevents the risk of the leaves of other plants being collected by mistake. The leaves should be completely dried immediately after collection, and kept in air-tight vessels.

**Characters.**—*Digitalis* leaves are from 10 to 30 Cm. or more in length, and may be as much as 12.5 to 15 Cm. broad. They are broadly ovate or ovate-lanceolate in-shape, with a blunt or subacute apex, and a crenate or irregularly crenate-dentate margin, the leaves on the upper part of the stem being narrower than the lower ones. The lamina is contracted towards the base of the leaf, and passes into a winged petiole of varying length, down which the lower veins are usually decurrent; the petioles are longest on the lower leaves. The upper, somewhat rugose surface of the leaves is dull-green in colour, and bears short, glandular, simple, usually three-celled hairs; the under surface is paler and densely pubescent, the hairs being simple and unbranched. The midrib is prominent on the under surface, and the majority of the lateral veins leave it at a rather acute angle, gradually curving round towards the apex and passing into smaller ramifications near the margin. A transverse section of a leaf shows the mesophyll to be free from crystals of calcium oxalate. The drug has a faint herb-like odour, and a very bitter taste, due to the glucosides it contains.



**Notes.**—The distinctive characters of digitalis leaves are the crenate margin, winged petiole with decurrent veins, simple unbranched hairs, and the course taken by the lateral veins. Matico leaves, from *Piper angustifolium*, somewhat resemble them, but have veinlets which are depressed on the upper surface, giving it a tessellated appearance. Other leaves which may be mistaken for those of digitalis, include: Mullein leaves, from *Verbascum thapsus*, which are woolly, with branched hairs; Comfrey leaves, from *Symphytum officinale*, are lanceolate and bear isolated stiff hairs; primrose leaves, from *Primula vulgaris*, are nearly spatulate or spoon-shaped, with straight lateral veins which divide near the margin; Ploughman's spikenard leaves, from *Inula conyza*, have a more or less denticulate margin, with horny points to the teeth when present. The chemistry of digitalis is far from clear, but digitoxin and digitalin appear to be the chief active principles naturally present in the drug. Digitoxin is extremely poisonous, and uncertain and cumulative in its action; digitalin is less toxic than digitoxin, and possesses in a high degree the medicinal action of digitalis without being cumulative. It has been stated that the seeds of digitalis, and probably also the leaves, contain an amorphous glucoside named digitalein, which is non-cumulative in its action on the heart and causes no irritation when injected subcutaneously. Commercial "digitalein," however, is said to be a mixture of digitoxin, digitalin, and true digitalein. Digitonin is another glucoside found in the seeds, and probably also present in the leaves; it is a body of the saponin class (*vide* Quillaia Cortex), possessing none of the physiological action peculiar to digitalis. The name digitophyllin has been applied to a crystalline substance isolated from digitalis leaves; it is probably methyl-digitoxin, but its physiological action has not yet been determined. Digitoflavone is a yellow colouring matter, allied to quercetin. Digitoxin, which occurs in the form of a white micro-crystalline powder, is undoubtedly the substance in which the properties of digitalis assert themselves with the greatest force, and it is probable that digitoxin and digitalin must be regarded as the only two substances of definite composition proved to exist in digitalis leaves, while crystalline digitoxin must be regarded as the product which possesses the most definite and constant therapeutic action.

[Dose.— $\frac{1}{2}$  to 2 grains.]

## Elaterinum.

**Elaterin**,  $C_{28}H_{38}O_7$ , is the active principle of elaterium, the dried sediment from the juice of the squirting cucumber, *Ecballium Elaterium*, A. Richard (N.O. Cucurbitaceæ). It appears to be formed in the juice, after expression, by the action of a ferment (elaterase) on an amorphous, bitter glucoside. Elaterium may yield as much as 33.6 per cent. of elaterin, although the commercial drug usually yields much less. Elaterin may be obtained by exhausting elaterium with chloroform, evaporating the solution to dryness, then washing the dry residue with ether, and crystallising from chloroform.

**Characters and Tests.**—Elaterin occurs in minute colourless, hexagonal scales or prismatic crystals, which are odourless, but have a slightly acrid, bitter taste. They are neutral to litmus and almost entirely insoluble in water, though sparingly soluble in ether or in 90 per cent. alcohol, and readily soluble in boiling

alcohol, carbon bisulphide, amyl alcohol or chloroform. When heated with access of air elaterin melts (melting point  $209^{\circ}\text{C}.$ ), and then burns without leaving any residue. It is dissolved by solutions of alkalies and reprecipitated on supersaturating with an acid. Added to melted phenol, elaterin yields a solution which becomes crimson on adding sulphuric acid, though the colour rapidly changes to scarlet. It is not coloured by chlorinated alkalies, and its alcoholic solutions should not yield a precipitate with solution of tannic acid, test solution of mercuric chloride, or solution of platinic chloride, thus indicating absence of alkaloids.

**Notes.**—The whole activity of elaterium is represented by elaterin, which is the most powerful hydragogue cathartic known. It is neither an alkaloid nor a glucoside, nor does it possess the properties of an acid; though, if solid potassium hydroxide be added to a boiling alcoholic solution, the neutral elaterin is converted into an acid body which is devoid of cathartic power.

[Dose.— $\frac{1}{40}$  to  $\frac{1}{10}$  grain.]

## Elaterium.

**Elaterium** is the dried sediment from the juice of the fruit of the squirting cucumber, *Ecballium Elaterium*, A. Richard (N.O. Cucurbitaceæ), a prostrate trailing plant which is common in Southern Europe, particularly in countries bordering on the Mediterranean, and is cultivated to a limited extent in England. The fruit of the plant is about 37.5 to 50 Mm. long, and resembles a small hairy gherkin; when ripe it separates suddenly from its stalk, and the seeds and juice are forcibly ejected from the aperture left where the fruit has parted from the peduncle. It is necessary, therefore, that the fruit should be collected before it is quite ripe; it is then sliced and pressed, the slightly turbid juice, which becomes more turbid on standing, being allowed to deposit. The sediment, after being collected, drained, and dried, constitutes the elaterium of commerce, which may either be prepared in England or imported from Malta.

**Characters and Tests.**—Elaterium occurs in light, friable, flat or slightly curved opaque pieces, about 2.5 Mm. thick. It is pale green, greyish-green, or yellowish-grey in colour, has a finely granular fracture, a faint tea-like odour, and a bitter, acrid taste, due to the presence of elaterin, of which it should contain from 20 to 25 per cent. or more. Elaterium should not effervesce with dilute acids or give a blue colour when iodine is added to a cooled decoction of the drug, thus indicating freedom from calcium or other carbonate, or starch. It should yield half its weight to boiling 90 per cent. alcohol, and not less than 20 to 25 per cent., consisting of elaterin, to chloroform.

**Notes.**—As prepared in England, elaterium is bright green in colour, owing to the presence of chlorophyll, but with age it becomes greyish-green and, finally, yellowish-grey, besides exhibiting minute crystals of elaterin on the surface. The Maltese drug contains less elaterin, and is yellowish-grey when imported. In addition to the active principle elaterin, of which it may contain as much as 30 per cent., elaterium usually contains chlorophyll, chalk, and starch, and is said to contain a crystalline, bitter glucoside named prophetin, which is soluble in ether and gives a brown-red colour with sulphuric acid. An amorphous bitter glucoside named elaterinid occurs in the freshly expressed juice, but

when the latter is allowed to stand the elaterinid is decomposed, by a ferment (elaterase) also present in the juice, into elaterin and glucose. The former, being nearly insoluble, is precipitated and, together with the mechanically suspended débris, constitutes the substance known as elaterium. [*Dose*.— $\frac{1}{10}$  to  $\frac{1}{2}$  grain.]

## Emplastra.

**Plasters** consist of medicaments incorporated or melted with a plastic, resinous basis, of such a nature that the resulting mixture, when spread upon leather, linen, or other fabric, shall become softened at the body temperature. The spread plaster then adheres, more or less closely, to the skin area to which it is applied, and by prolonged contact with the surface of the body, the medicament or its active principles are slowly absorbed. The plaster-base usually exerts some effect itself, by virtue of the increased local circulation produced, partly by increased warmth, and partly by the local stimulating effect of its resinous and waxy constituents. The official formulæ appear, in some cases, to be needlessly complicated; but, although they might possibly be simplified, tradition favours the retention of those formulæ which have been handed down from mediæval pharmacy. It would be found impossible to employ a uniform plaster-base in all cases, because the addition of the medicament alters the consistence of the plaster, and this alteration must be compensated by the addition of other ingredients to harden or soften the finished plaster to the required consistence. There are twelve official plasters:—

### **Emplastrum Ammoniaci cum Hydrargyro.** AMMONIACUM AND MERCURY PLASTER.

Metallic mercury is finely subdivided by trituration with sulphurised oil, and then incorporated with purified ammoniacum. Contains about 1 in 5 of mercury.

### **Emplastrum Belladonnæ.** BELLADONNA PLASTER.

The standardised liquid extract should be concentrated at a low temperature to remove most of the alcohol, and the residue incorporated with resin plaster. This plaster is said to be too strong, and to cause too much irritation. Contains about 4 of liquid extract in 6, or 0.5 per cent. of belladonna alkaloids.

### **Emplastrum Calefaciens.** WARMING PLASTER.

Cantharides are infused in boiling water, and the concentrated infusion incorporated with the plaster basis. This is intended to have only a mild action, and not to produce blisters. Contains the water soluble constituents of about 1 part of cantharides in 25 parts.

### **Emplastrum Cantharidis.** CANTHARIDES PLASTER.

The powdered cantharides are incorporated with the plaster base, which is soft and plastic at ordinary temperatures, so that the spread "blister" may be removed from the skin without injury to the latter. Contains about 1 in 3 of cantharides.

### **Emplastrum Hydrargyri.** MERCURIAL PLASTER.

Mercury is finely divided by trituration with sulphurised oil, and incorporated with melted lead plaster. Contains 1 in 3 of mercury.



**Emplastrum Menthol.** MENTHOL PLASTER.

Menthol is incorporated with beeswax and resin at a low temperature, just above their melting point, so as to avoid loss of menthol by volatilisation. Contains 15 per cent. of menthol.

**Emplastrum Opii.** OPIUM PLASTER

Finely powdered opium is incorporated with melted resin plaster. Contains 10 per cent. of opium.

**Emplastrum Picis.** PITCH PLASTER.

Contains Burgundy pitch (1 in 2); frankincense, resin, yellow beeswax, and olive oil.

**Emplastrum Plumbi.** LEAD PLASTER.

Consists chiefly of lead oleate and palmitate, with some glycerin and water. Made by boiling lead oxide and water with olive oil.

**Emplastrum Plumbi Iodidi.** LEAD IODIDE PLASTER.

Contains 10 per cent. of lead iodide.

**Emplastrum Resinæ.** RESIN OR ADHESIVE PLASTER.

Resin with lead plaster and a smaller proportion of hard soap. Similar in composition to soap plaster, but the larger proportion of resin makes it more adhesive.

**Emplastrum Saponis.** SOAP PLASTER.

Hard soap with lead plaster and a smaller proportion of resin. Less tenacious than resin plaster.

## Ergota.

**Ergot** is the sclerotium or compacted dormant mycelium of a fungus, *Claviceps purpurea*, Tulasne, representing the resting stage in the development of that plant. It is found occupying the place of some of the grains in the ears of the rye plant, *Secale cereale*, Linné (N.O. Gramineæ), and other grasses, though only that which originates and develops in the ovary of the rye plant must be used for medicinal purposes. In the case of rye and several other grasses the "ergots" are much larger than the natural grains, and stand out conspicuously from the glumes of the inflorescences, but in the case of wheat and many smaller grasses the sclerotia are not larger than the grains they displace. The ergot has attained its full development when the ears of rye have ripened, and it is then collected by hand, or separated from the grain after it has been threshed by specially designed machinery. After collection it is carefully dried, and is then ready for use. The chief commercial varieties of the drug are the Spanish, Russian, and German, but Austrian, Swiss, Norwegian, and Swedish ergots also come into the market occasionally. Spanish ergot is generally largest and of the finest appearance, but it is said to be less active than the Russian.

**Characters and Tests.**—Ergot occurs in very dark violet-black grains, which are about 1·5 to 4 Cm. long, subcylindrical or somewhat triangular in cross-section, tapering towards the ends, and generally curved. At one end of the grain

may sometimes be found a small whitish appendage. The grains are longitudinally furrowed, especially on the concave side, and often bear numerous small, irregular, transverse fissures. They break easily, with a very short fracture, are whitish or pinkish-white inside, and do not exhibit any definite structure when examined with a lens. The peculiar odour and oily taste of ergot are alike disagreeable. The odour is given off in a more marked degree if the powdered drug be triturated with potassium hydroxide solution, probably owing to the formation of methylamine, trimethylamine, or some similar decomposition product of albuminoid matters present. Ergot should not be exposed to damp, or it will deteriorate, especially if it be kept in the powdered state, the drug acquiring a musty or putrid odour. Deterioration may also be caused by oxidation of the fixed oil present in the drug, or by the attacks of mites belonging to the genus *Trombidium*. The drug yields about 3 per cent. of ash.

**Notes.**—Ergot affords an interesting case of homologous alternation of generations, two kinds of gametophyte being produced in the course of its development. After being kept through the winter the sclerotium germinates on being moistened, and sends up several fleshy, pink stalks with rounded heads (stromata), embedded in the substance of which are a large number of flask-shaped cavities termed perithecia. The narrow end of each perithecium has a small opening, the position of which is indicated by a slight depression on the outer surface of the rounded head, and from the base of the interior of the perithecia arise long club-shaped cells (asci), each of which contains eight thread-like ascospores. The ascospores ripen about the time grasses are in flower, and are then shot out of the asci, through the openings of the perithecia, into the air. Conveyed by the wind to the inflorescence of a grass, they germinate and penetrate into the base of an ovary, the germ-tube feeding on the substance within the latter and developing into a white closely-woven felt-like mass (mycelium), on the outside of which are produced a number of short thread-like branched bodies (hyphæ), bearing single, small, oval reproductive cells (conidia or gonidia), which float in a sweet, slightly milky juice ("honey-dew") secreted by the fungus at this stage of its development. Insects attracted by the sweet liquid convey the conidia to other inflorescences, where they germinate and give rise to new mycelia similar to those produced by the ascospores, the fungus being propagated in this manner throughout the summer. Meanwhile, the mycelium originally produced by the ascospores continues to grow and forms a compact, elongated mass of hyphæ, which pushes aside the withered ovary of the host-plant, or carries it on its apex. When the formation of conidia ceases, in the late summer, the fully-grown mycelium becomes transformed gradually into the firm, dark-coloured sclerotium, which, when mature, constitutes the drug known as ergot, or, if allowed to fall to the ground, remains dormant during the winter, and then recommences the cycle of changes which have been described. Various substances have been described as being the active principles of ergot, but the most important constituent of the drug appears to be the crystalline, water-soluble alkaloid ergotamine or *p*-hydroxy-phenylethylamine, which appears to be formed by the decomposition of an amino-acid under the influence of bacterial activity; it is also found in putrid meat and certain varieties of cheese, is closely related to adrenine and

hordenine, and can be produced synthetically from tyrosine or by the reduction of *p*-hydroxyphenylacetonitrile. Ergot also contains the crystalline alkaloid ergotinine (picrosclerotine, sclerocrystalline, or secaline), which possesses but slight physiological action, and the more active amorphous alkaloid ergotoxine (hydro-ergotinine or cornutine), which can be converted into ergotinine by boiling with acetic anhydride or methyl alcohol. The name clavin has been given to an inert mixture of leucine and other amino-acids, obtained from ergot. Other constituents of ergot are physiologically inert acid substances and resinous bodies to which various names have been applied—ergosterol or ergosterin, trehalose, mannite, and about 30 per cent. of fixed oil. The name ergotin is usually applied to the purified extract, and not to any one definite proximate principle. [Dose.—20 to 60 grains.

## Eucalypti Gummi.

**Eucalyptus** or **Red Gum** is a variety of Botany Bay kino, which exudes from the bark of *Eucalyptus rostrata*, Schlechtendal (N.O. Myrtaceæ), and other species of *Eucalyptus*, the product of *E. rostrata* being preferred for medicinal purposes. The tree is very common on the banks of the Murray River, New South Wales, and other species—*E. marginata*, *E. amygdalina*, *E. sideroxylon*, *E. fissilis*, etc.—which yield similar kino-like gums, are also natives of Australia. The gum is secreted as a treacly liquid in cavities in the wood, or between the bark and the wood. It may exude naturally and be found in the dry state in cavities of the trunk, but it is usually collected by making incisions in the trees, inserting trough-shaped pieces of tin, and allowing the viscid liquid to drain into buckets or tins. The average yield of each tree is rather more than a litre; some yield very little, others have been known to yield as much as 18 litres. The liquid dries into a solid mass in a few days, but the process of evaporation is sometimes hastened by the application of artificial heat.

**Characters and Tests.**—Eucalyptus gum occurs in bright ruby-coloured or opaque brownish grains or small masses, thin fragments being transparent; the powdered gum is pale red. Fragments of the gum are somewhat tough and have a very astringent taste, owing to the presence of much tannin; when chewed the gum adheres to the teeth and the kino-red it contains gives the saliva a reddish tinge. It should be almost entirely soluble in 90 per cent. alcohol and dissolve to the extent of 80 to 90 per cent., or more, in cold water, forming a neutral solution.

**Notes.**—The principal constituent of eucalyptus gum is kinotannic acid, of which it may contain about 47 per cent.; other constituents are a phlobaphene (kino-red), a gelatinisable tannin glucoside, catechin, pyro-catechin (catechol), and sometimes volatile oil. The original red gum tree is undoubtedly *E. rostrata*, but the product of several other species satisfies the official requirements. Many red gums are only imperfectly soluble in alcohol or water, and it is to be noted that the solubility of all eucalyptus gums may be affected on keeping, owing to the action of an oxydase which they contain. Opaque, brownish gums are more soluble than bright ruby-coloured varieties, and therefore more suitable for pharmaceutical use. [Dose.—2 to 5 grains.



## Euonymi Cortex.

**Euonymus** or **Wahoo Bark**, is the dried root-bark of the *Euonymus atropurpureus*, Jacquin (N.O. Celastrineæ), a tall erect shrub, common in shady woods in the eastern United States, southward to Florida and westward to Wisconsin.

**Characters.**—Euonymus bark occurs in small, more or less irregular, quilled or curved pieces, varying in thickness from 2 to 4 Mm., and not usually exceeding 7.5 Cm. in length, or 12.5 Mm. in width. The outer layer of the bark is a soft, finely-fissured cork of a light ash-grey colour; it is friable and easily removed with the finger nail. There are occasional small transverse scars and darker lines or patches on the bark. The inner surface of the bark is of a pale tawny white or buff colour and smooth, except when some of the whitish or pale yellow dense wood adheres to it, as is sometimes the case owing to the difficulty experienced in separating the bark from the root. The bark breaks with a very short fracture, the fractured surfaces appearing yellowish and—when separated very gently—connected by delicate silky threads, said to be formed by the mucilaginous contents of some of the cells of the bast. A transverse section exhibits, when moistened, a narrow whitish cork, a pale cortex and the darker bast. The faint but characteristic odour of the bark is due to the presence of a pungent principle; the euonymin the drug contains causes it to taste bitter and slightly acrid.

**Notes.**—The distinctive characters of euonymus root-bark are the friable grey cork, the silky threads connecting fractured surfaces when carefully separated from one another, and the bitter taste. Euonymus stem-bark may be recognised by its occurrence in long, thin, narrow strips, its dark greenish-grey cork, green cortical portion, and fibrous bast. The chief constituent of the root-bark is euonymin, a nearly colourless, amorphous and intensely bitter principle, which is soluble in alcohol or water. The bark also contains atropurpurin (probably dulcite or an isomer), asparagin, a bitter extractive, and a pungent principle, together with citric, tartaric, and malic acids, various resins, fixed oil, wax, starch, pectin, etc. Commercial euonymin is a powdered extract of euonymus bark.

## Extracta.

**Extracts** constitute a very important group of galenical preparations. The main idea in preparing an extract of any given drug is to obtain a concentrated preparation containing the full activity of the drug without the inert cellulose and woody tissue which constitute the framework of vegetable structures. In the case of succulent leaves or herbs, which can be obtained in the fresh condition, evaporation of the expressed juice, conducted with suitable precautions, yields in many cases an extract having the desired properties, as in the case of the extracts of colchicum and taraxacum, and the "green" extracts of belladonna and hyoscyamus. In the case of drugs which are not available in the fresh condition, or which yield little or no juice by expression, such as most roots, stems, and barks, the general process adopted is to exhaust the drug by treatment with a suitable menstruum, the residue obtained by the evaporation of the fluid so obtained constituting the extract. The menstrua usually

employed are water, alcohol of various strengths, ether, and dilute acids. Water is obviously the most economical menstruum to employ in cases where its solvent action is satisfactory (*e.g.*, Extractum Gentianæ); its use, however, is attended by certain drawbacks. Owing to the comparatively high latent heat of steam, the evaporation of an aqueous fluid requires the application of so much heat that the extract is liable to suffer if the active principle is easily decomposed, as in the case of many alkaloids. An aqueous extract is also usually bulky, owing to the solubility in water of inert matters—chiefly gum and albumin (proteid)—which occur more or less abundantly in all vegetable tissues. In both those respects alcohol is superior to water as a menstruum, less heat being required for its evaporation, and less inert material being dissolved by alcohol than by water. Owing to the cost of alcohol, it is usually recovered by distillation, though, on the small scale, the portion retained by the marc is frequently recovered as far as possible by expression or by displacement with water. The drug should be exhausted with the smallest possible quantity of fluid in order to minimise the duration of subsequent evaporation and consequent risk of damaging the product, and evaporation is generally conducted at the temperature of the water bath, or—in cases where that temperature would be prejudicial—lower, *e.g.*, about 80° C. (Extractum Cinchonæ Liquidum), 71° C. (Extractum Colchici), or 60° C. (“green” extracts). Medicinal extracts, therefore, may be regarded as plant juices, infusions, decoctions, or tinctures, evaporated to a greater or less degree, the products differing only, as a rule, from the original preparations in the degree of concentration and the permanency of their condition. Some degree of concentration, with or without the addition of alcohol as a preservative, is essential in the case of aqueous solutions of many of the proximate principles existing in drugs, as such solutions are peculiarly liable to fermentation, and any saccharine, albuminoid, or mucilaginous matter they contain may then be decomposed, with the formation of alcohol, ammonia, lactic acid, acetic acid, and various other products of putrefaction. At the same time, in order to prevent decomposition of the active principles in solution, great care must be taken, in concentrating the liquids, to avoid unduly prolonged exposure to air or to the action of heat; it is desirable, therefore, that the process of evaporation should be conducted as expeditiously and at as low a temperature as possible. Evaporation is hastened by employing pans which are very wide in proportion to their depth, since it only takes place from the surface of the liquid, and the larger the surface exposed, the greater is the rate at which evaporation proceeds. The superincumbent air should also be constantly removed as the vapour from the liquid diffuses into it; otherwise evaporation will be retarded. In addition, it is found that constant stirring tends to expedite the process, mainly by breaking the thin film or pellicle which usually forms upon the surface of the liquid at a certain stage in the inspissation of extracts, and tends to prevent the escape of vapour. Evaporation *in vacuo*, although not mentioned in any of the official processes, is usually employed when working on a large scale, particularly if a low temperature is necessary, since the time occupied in the process is very much diminished

thereby. By reference to the Pharmacopœia it will be observed that the official processes for exhaustion are of a very heterogeneous nature. That is partly due to the fact that each drug requires more or less special treatment according to its physical properties and the nature of its constituents, and although there is little doubt that much greater uniformity in the preparation of extracts is possible, alteration—merely for the sake of uniformity—of the formula for an extract which has a time-honoured reputation would not be justified unless experimental work were available to show that the medicinal activity of the product would not be diminished thereby. In the case of solid extracts it is officially directed that the evaporation must be continued until the product “is of the consistence of a soft extract” (*e.g.*, Extractum Belladonnæ Viride); or “to the consistence of a firm extract” (*e.g.*, Extractum Jalapæ); or to dryness. Those directions are somewhat vague, and admit of considerable variation in their interpretation. The strength of solid extracts is consequently liable to vary, and evaporation to dryness, as is directed for the extracts of aloes and krameria, would secure more uniformity in that respect. Many extracts, however, will not readily yield a dry residue, and the application of prolonged heat is to be avoided; moreover, the dried product is not usually readily soluble. The process of standardisation, again, can only be applied to a few extracts, since such a procedure requires a more intimate knowledge of the active principles of many drugs than is at present available. Further, any process of standardisation, to be practicable, must be simple and capable of rapid completion. The simplest form of standardisation is that adopted in the case of certain liquid extracts, which are prepared so that one fluid ounce contains the soluble constituents of one ounce by weight of the drug; such extracts, when prepared with water, require the addition of alcohol to preserve them from decomposition.

### CLASSIFICATION OF EXTRACTS.

In considering the official formulæ for extracts some form of classification must be adopted in order to avoid needless repetition, and to bring into relief points of analogy or difference among the individual members of the groups. The following scheme of classification will be found as convenient as any:—

A. Solid or Semi-Solid Extracts.	{	INSPISSATED JUICES.....	{	Extractum Belladonnæ Viride.
				“ Colchici.
				“ Hyoscyami Viride.
				“ Taraxaci.
	{	ALCOHOLIC EXTRACTS .....	{	Extractum Belladonnæ Alcoholicum.
				“ Cannabis Indicæ.
				“ Colocynthis Compositum.
				“ Ergotæ.
				“ Euonymi Siccum.
				“ Nucis Vomicae.
				“ Physostigmatis.
				“ Rhei.
				“ Stramonii.
				“ Strophanthi.



A Solid or Semi-Solid Extracts.	{	AQUEOUS EXTRACTS.....	{	Extractum Aloes Barbadosis.	
				„ Anthemidis.	
				„ Cascaræ Sagradæ.	
				„ Gentianæ.	
				„ Glycyrrhizæ.	
				„ Kramerizæ.	
				„ Opii.	
		OTHER SOLID EXTRACT ...	{	Extractum Jalapæ.	
B. Liquid Extract.	{	ALCOHOLIC EXTRACTS .....	{	Extractum Belladonnæ Liquidum.	
				„ Cimicifugæ Liquidum.	
				„ Cocæ Liquidum.	
				„ Hamamelidis Liquidum.	
				„ Hydrastis Liquidum.	
				„ Ipecacuanhæ Liquidum.	
				„ Jaborandi Liquidum.	
				„ Nucis Vomizæ Liquidum.	
				„ Sarsæ Liquidum.	
	„ Ergotæ Liquidum.				
	„ Glycyrrhizæ Liquidum.				
	„ Opii Liquidum.				
	„ Pareiræ Liquidum.				
		OTHER LIQUID EXTRACTS	{	Extractum Cinchonæ Liquidum.	
	„ Filicis Liquidum.				
	„ Taraxaci Liquidum.				
A or B. Standardised Extracts.	{	SOLID .....	{	Extractum Belladonnæ Alcoholicum.	
				„ Nucis Vomizæ.	
				„ Opii.	
			LIQUID .....	{	Extractum Belladonnæ Liquidum.
		„ Cinchonæ Liquidum.			
		„ Ipecacuanhæ Liquidum.			
		„ Nucis Vomizæ Liquidum.			
		„ Opii Liquidum.			

**Solid Extracts** are mostly given in the form of pills, and do not require special comment here, except in the case of the four inspissated juices prepared by bruising or crushing the fresh drug, pressing out the juice, and evaporating it to a soft pilular consistence. In the case of the green extracts of belladonna and hyoscyamus the expressed juice is first heated to 54° C. in order to cause the separation of the chlorophyll or green colouring matter of the plants, which is then removed by straining the heated juice through calico. The strained liquid is next heated to 93° C., to cause the albumin to coagulate, and, after the coagulum has been filtered out, the filtrate is evaporated to the consistence of a thin syrup at a temperature below 100° C., a water-bath being used to avoid the risk of injury by over-heating. The green colouring matter previously separated is then added to the syrupy liquid, having first been passed through a

hair sieve in order to subdivide it, and, after the mixture has been well stirred, evaporation is continued at a temperature not exceeding  $60^{\circ}$  C., until the extract attains the desired consistence. The chlorophyll is removed in the first instance because it is desired to retain it—unaltered and free from albumen—in the finished extract, and it would, otherwise, be strained out with the coagulum of albumen subsequently produced; it would also be injured by exposure to the temperature required to cause the albumen to coagulate. In the original process devised for these “green” extracts, the chlorophyll was returned to the extract because it was supposed to impart a better consistence and to keep it in a more satisfactory condition. Its retention, however, can only be regarded now as a concession to sentimental considerations. The albumin is removed from the extracts because it would promote decomposition if allowed to remain. In the case of the extracts of colchicum and taraxacum there is no chlorophyll to separate; hence, after the feculence due to the presence of starch or inulin has been allowed to subside, the clear liquid is at once heated to  $100^{\circ}$  C., to cause albuminous matter to separate, then strained and evaporated to a soft pilular consistence.

**Liquid Extracts** are chiefly intended for administration in mixture form, *i.e.*, in association with a liquid vehicle, for which purpose they are obviously more suited than the solid extracts, administration of which in fluid form requires a good deal of manipulation that, in many cases, does not yield a satisfactory product. In preparing the liquid extracts, the main object is the same as that described under the solid extracts, *viz.*, to withdraw the soluble constituents from a crude drug by treatment with a suitable solvent, and by suitable manipulation to bring their solution into a concentrated condition. The concentration is carried out in such a manner that the volume of finished liquid extract bears some simple relationship to the weight of drug operated upon, or it is adjusted in accordance with the proportion of active constituents found by analysis in the fluid. The former principle is adopted in the case of liquid extracts from drugs which, in the present state of knowledge, cannot be standardised by analysis, and the finished volume of the official liquid extracts of this nature is so adjusted that one part by measure is obtained from one part by weight of the crude drug. The adjustment of the finished volume of the standardised extracts is usually accomplished by first bringing the fluid to such a state of concentration as will ensure it containing—when drugs of average quality are employed—more than the required proportion of alkaloid or other constituent upon which the standardisation is based. The exact proportion of this having been determined by assay, the fluid will then require more or less dilution, in order to adjust its strength to the required potency. This form of procedure is adopted in order to avoid the risk that the proportion of alkaloid, etc., having been once determined, may suffer any chance of alteration by the action of heat or other changes which might be produced by further concentration. Only in exceptional cases does water form the most suitable menstruum for the preparation of liquid extracts, since, as already explained, the concentration of aqueous lipuors by evaporation requires a more prolonged application of heat than that of alcoholic liquors, not only on account of the higher boiling

point of water, but also on account of its high latent heat of vaporisation. Aqueous liquid extracts also require the addition of antiseptic substances in order to protect them from fermentation and various forms of putrefactive decomposition, induced by the presence of organisms which gain access to the fluid. For this purpose alcohol is the most suitable antiseptic, and is the only one employed in the official formulæ. Antiseptics like mercuric chloride and phenol are prohibited on account of their toxic effects, while non-poisonous antiseptic substances like boric, salicylic, and benzoic acids are in some cases ineffectual, and their presence would cause the extracts to become incompatible with many other things often prescribed with them. Chloroform in very small proportions is a very effectual antiseptic to which no objection can be raised, but weak aqueous solutions of chloroform are eventually decomposed, so that preservation with chloroform suffers from the disadvantage of a time limit. Alcohol, on the other hand, is harmless, not liable to chemical change, and introduces no chance of incompatibility, while its addition to aqueous fluid extracts often effects their clarification by precipitating mucilage and other inert matter whose presence in solution renders the liquids viscous and difficult to filter.

**Standardised Extracts** are solid or liquid extracts whose weight or volume is adjusted in the completed product, in relation to the proportion of active principles the preparations contain, and not in relation to the weight of crude drug employed. This is the principle of standardised galenical preparations—the selection of some standard of potency based upon the proportion of active principles present in the preparation, so as to eliminate the effect of variations in the proportions of these active principles in the drug itself. That principle is dealt with at length in the following appendix to which the attention of readers may profitably be directed. It is only necessary to state here that the application of standardisation to a given drug requires, speaking broadly, (1) that pharmacologists shall be agreed as to the substances upon which the main, if not the entire, activity of the drug depends, and (2) that chemists shall be able to devise rapid and accurate methods of assay for determining the proportion of those substances present in the drug and its preparations. In comparatively few cases can those two conditions be realised, and at present only the preparations of opium, cinchona, belladonna, nux vomica, jalap, and ipecacuanha are officially standardised.

### PRINCIPLES OF STANDARDISATION.

Analysis of crude drugs has abundantly revealed the fact that the proportion of active principles contained therein varies within wide limits, and such variation is not necessarily accompanied by corresponding variations in the physical characters of the different samples. It is true that the expert pharmacognosist may often, by observation of physical characters alone, separate a number of samples of a given drug into good, bad, and indifferent, and may by this means arrive at results which accord fairly well with subsequent chemical analysis. Two samples, however, may often exhibit the physical appearances characteristic of the good and genuine article, and yet



contain widely different proportions of the active principles upon which their activity depends. The chief causes which influence those variations are locality, soil, climate, cultivation, season, time, collection, care taken in collecting, age of the plant, and conditions of preservation. The exact influence of the various conditions are either not yet sufficiently known or not sufficiently under the control of the grower to enable him to place his drugs upon the market in a condition of uniformity so far as active principles are concerned. It is therefore a great gain for practical medicine when those variations can be eliminated from the galenical preparations of a drug by adjusting their strength to some accepted and convenient standard, based upon the actual amount of the active principles known, and found by analysis, to be present therein. The advantage is, indeed, so obvious as to suggest the desirability of extending the application of the principle of standardisation to all galenical preparations. This extension, however, demands a more complete knowledge of the pharmacology and chemistry of drugs than we at present possess. The suggestion to base the standardisation of galenicals upon total extractive matter (Compare liquid extracts of liquorice and pareira) has also been made, in dealing with certain drugs whose active principles are unknown, or cannot be isolated with sufficient ease for standardisation to be based upon them alone. Such a standard, however, would be rather delusive, because the ratio of active principle to total extractive is never constant for those drugs in which this point has been investigated. Standardisation, therefore, is only applied in those cases mentioned on the previous page, while, in the case of other drugs, the existing pharmacological or chemical knowledge of their constituents is considered insufficient for a rational process of standardisation to be based thereon. Thus, *digitalis* leaves contain more than one active substance, and it is not yet certainly known upon which, or how many of those, the useful medicinal action of the drug depends. Moreover, if that were decided, the difficulty of devising a sufficiently quick and accurate method of assay would still remain. *Strophanthus*, for example, contains the glucoside *strophanthin*, to which its action is due, but it is not possible, at present, to standardise its preparations for want of a suitable method of assay. As our knowledge progresses, however, many drugs may eventually become susceptible of standardisation, but there is another limitation to the universal application of the principle which has not yet been discussed. The time and labour involved in carrying out the standardisation processes naturally increase the cost of the finished products; hence this increased cost must be justified by some real and practical advantage. In the case of many comparatively innocuous drugs no corresponding advantage would ensue, and, therefore extension of the principle of standardisation to the whole of the vegetable *materia medica* will probably never happen. Having discussed the principles upon which the application of standardisation processes are based, it must now be admitted that the logical consequence of improved knowledge which first renders standardisation possible will ultimately result in the rejection of galenical preparations in favour of the pure active principles themselves. For as soon as our knowledge of the relative activities of the crude drug and its active principles is complete, and we are able to effect

the separation of the latter with sufficient ease, there will be no excuse for administering them in association with the thousand and one inert substances, wax, oil, fat, proteids, gum, colouring matter, etc., which accompany them in their galencial preparations. This has already happened to a large extent in many cases; *e.g.*, quinine in place of cinchona, and such changes may, in the future, be expected to extend. In opposition to such changes is the opinion held in some quarters that the medicinal action of some, if not all, vegetable drugs can never be entirely represented by their so-called active principles. This opinion implies that the action which we attribute to these active principles is, in the crude drug, modified by the natural form of combination in which they occur, or by association with, other substances of subsidiary importance. Although in many cases founded only upon tradition, this opinion must yet be respected, and only set aside if it can be shown by practical experience to have no rational foundation. It must, in any case, be remembered that many drugs have found a place in the materia medica solely by virtue of the medicinal action which the crude substance or its galencial preparation has been found to possess, and changes in the direction indicated must therefore be justified by practical and experimental results.

**Alkaloidal Determinations.**—The active principles, whose determination constitutes the object of standardisation, may belong to any of the numerous varieties of proximate vegetable principles, and therefore no general process can be devised which is applicable to all substances. Moreover, the chemical and physical characters of the different classes of proximate principles lend themselves with varying degrees of facility to standardisation processes, glucosides and neutral bitter principles, for example, being much more difficult to deal with than acid and basic substances. For this reason the official processes of standardisation are restricted at present to alkaloidal determinations, and the causes which lead to this result will be seen in the description of the general process which follows. The general method adopted in alkaloidal assays is to bring the substance to be assayed into a liquid condition which is generally that of an aqueous or weakly alcoholic solution. This fluid is then agitated with another solvent immiscible with the first, so that after agitation, the mixture separates into two distinct layers, the fluid of higher specific gravity being naturally found below the other. The various substances present in the first fluid will be found to have distributed themselves in accordance with their relative solubilities in these two fluids. Thus, speaking broadly, if a given substance be fifty times more soluble in fluid A than fluid B, and a given weight of it be agitated with equal volumes of these two fluids, then after separation  $\frac{49}{50}$ ths of it will be found dissolved in A, and  $\frac{1}{50}$ th in B. If the solvent layer A be now removed and an equal volume of fresh fluid A be agitated again with B, then  $\frac{49}{50}$ ths of the  $\frac{1}{50}$ th part of the substance remaining in B will be withdrawn from it by the second portion of A. After the second agitation only  $\frac{1}{50} \times \frac{1}{50} = \frac{1}{2500}$  of the original weight of the given substance will therefore remain in B, and after a third treatment only  $\frac{1}{2500} \times \frac{1}{50} = \frac{1}{125000}$ , or about 0.000008

gramme if 1 gramme of the original substance had been taken (on theoretical grounds). It will be seen, therefore, that it is impossible to remove a given substance entirely from its solution by agitation with another fluid in which it is more soluble, however great the difference in its solubility in the two fluids respectively, or however many times the agitation be repeated with fresh solvent. But when there is any considerable difference in the relative solubility of any substance in the two fluids, three agitations remove so much that the remaining portion may be disregarded on account of its small amount. There are, nevertheless, several reasons why the separation by means of immiscible solvents is not so complete as might be expected from the theoretical example which has been given. Thus, the two fluids are never absolutely mutually insoluble in each other, so that the layer of A always contains some of B dissolved in it, and *vice-versâ* in the case of the layer B. The presence of B in A or of A in B modifies the behaviour of those two fluids towards the substance distributed between them, and generally tends to diminish the difference between the observed solubility of the substance in the two fluids when pure and unmixed. The solubility of the substance to be determined is also considerably modified by the presence of the other substances extracted with it from the crude drug. Again, it is impossible to separate the two immiscible layers completely, owing to the formation of an intermediate emulsified layer, or to the adherence of droplets of the two fluids to the sides of the containing vessel. But substances may be separated with sufficient completeness from a given solution by agitation with another non-miscible fluid. It can also be shown, on theoretical grounds, that more complete separation is effected by repeated agitation with small portions of the non-miscible fluid than by one agitation with the whole quantity, and this result is confirmed by practical experience. The chief non-miscible fluids employed in these processes are chloroform, ether, benzene, amylic alcohol, carbon disulphide, and petroleum ether, either singly or mixed in various proportions. The selection of the solvent non-miscible with water depends upon the solubility of the substance to be determined, and upon the solubility of the substances from which it is to be separated, and which are associated with it in the fluid to be assayed. Another point to be considered is the facility and completeness with which the non-miscible fluid separates from the aqueous fluid after agitation, and since the aqueous fluid usually contains a complex mixture of organic vegetable substances the selection must be guided in each case by experiments with various fluids, which are known to possess the required solvent properties. In what follows it will be convenient for the sake of brevity to speak of the fluid immiscible with water as the "ethereal" fluid.

**Official Assay Processes.**—The problem in the official assay processes is to separate the required alkaloid from the other substances which are present in the galenical preparation. Those are included in the somewhat vague term, "extractive matter," but for the sake of clearness it will be well to consider the behaviour of the chief classes of proximate vegetable principles which together constitute the bulk of this "extractive." They include colouring matters, organic acids, resins, proteids (albumin), gum, sugar, and



fats (including oils and waxes). When such a mixture is submitted to the simultaneous solvent action of water and an ethereal liquid the proteids, gums and sugar will be found chiefly in the aqueous layer, and the fats, resins, and organic acids in the ethereal layer. The distribution of the colouring matters cannot be thus stated in general terms on account of the great variety in the chemical constitution of substances of this class. The distribution of the alkaloids will also depend upon the state of combination in which they occur in the fluid to be assayed. The condition of things thus described is, however, profoundly influenced by the reaction of the aqueous fluid, and since this condition can be varied at the will of the operator it constitutes a valuable means of controlling the selective solvent action of the fluids. Thus, if some dilute mineral acid be added to the mixture the alkaloids, whatever their original state of combination may have been, are converted into salts which are always—particularly in presence of excess of acid—more soluble in the aqueous than the ethereal layer. If, however, the mixture be rendered alkaline (the hydroxides or carbonates of ammonium, potassium, or sodium are usually employed), then the alkaloid will be set free from its combination, and free alkaloids are usually sparingly soluble in water and much more freely soluble in ethereal solvents. They will therefore pass chiefly into the ethereal layer. On the other hand, the fats will be saponified by the alkali and the alkaline soap will go chiefly into the aqueous layer. The resins also for the most part are bodies of acid or phenolic constitution, and although their acid properties are weak compared with mineral acids, they combine with alkalies to form compounds—the so-called resin soaps which are soluble in water—and hence resins are withdrawn from the ethereal and pass into the aqueous layer on the addition of excess of alkali. The same change occurs with the organic acids which combine with the alkaline base to form the corresponding alkali salts, which are also more soluble in water than ethereal fluids. It will thus be seen that the relative solubilities of proteids, gums, and sugar in water and ethereal fluids are not greatly modified by altering the reaction of the mixture. The relative solubilities of the fats, resins, and organic acids are however, reversed by changing the reaction of the fluids from acid to alkaline or *vice versa*, and this change is the reverse of that produced at the same time in the solubility of the alkaloids. It is this which renders comparatively easy the separation of alkaloids from the complex mixture of substance found in galenical preparations. The distribution of those substances under the various conditions described will be shown more clearly by the schematic representation at page 176, which, of course, must be regarded as illustrating the general principles only. In this scheme a liquid—such as an extract dissolved or diffused in water, a liquid extract diluted with water, or a tincture partially evaporated to remove most of the alcohol and then re-diluted with water—is assumed to be agitated with a suitable solvent-fluid immiscible with water. After separation, the distribution of the substances will be, generally, as shown; and in any given case this distribution of material between the two fluids will be influenced by the reaction of the mixture, in the manner indicated by the table.

DISTRIBUTION OF THE CHIEF TYPES OF PROXIMATE VEGETABLE PRINCIPLES when agitated simultaneously with water and ethereal solvents under the following conditions:—A, in neutral solution; B, in acid solution; C, in alkaline solution.

A. Neutral solutions.	{	Aqueous layer ... ..	{	Proteids.
				Gums.
				Sugars.
			{	Organic salts.
	{	Ethereal layer ... ..		Resins.
				Fats.
				Organic acids.
		Distribution variable ... ..	{	Alkaloids and their salts.
				Colouring matters.
B. Acid solutions.	{	Aqueous layer ... ..	{	Proteids.
				Gums.
				Sugars.
			{	Alkaloidal salts.
	{	Ethereal layer ... ..		Excess of added acid.
				Resins.
				Fats.
		Distribution doubtful ... ..	{	Organic acids.
				Colouring matters.
C. Alkaline solutions.	{	Aqueous layer ... ..	{	Proteids.
				Gums.
				Sugars.
			{	Resins.
	{	Ethereal layer ... ..		Fats
				as alkali salts (soaps).
				Organic salts of added alkali.
		Distribution doubtful ... ..	{	Excess of added alkali.
				Alkaloids (free).
				Colouring matters.

If now the aqueous layer from B be separated, rendered alkaline, and shaken with more ethereal solvent the alkaloid passes into this, leaving the proteids, gums, sugars, and alkaline salts in the alkaline aqueous layer. By the evaporation of the ethereal fluid an alkaloidal residue, more or less pure, is obtained. If the ethereal layer from C be evaporated an alkaloidal residue is obtained directly. In actual practice the matter is not so simple as it appears from the above representations. Thus the evaporation of the ethereal solvent from C seldom yields an alkaloidal residue sufficiently pure for the purpose of standardisation, because the saponification and separation of the fats and resins is only completely effected by using a strong solution of potassium or sodium hydroxide for the purpose of alkalisng the fluid. This is in many cases inadmissible, for the strong alkali may decompose the alkaloid itself or form a soapy liquid from which the ethereal layer will not separate after agitation. The presence of colouring matters also frequently introduces difficulties in separa-

tion. No general rule can be given for the distribution of colouring matters in the solvents, owing to the diversity of constitution exhibited by the vegetable substances of this class. They may be more soluble in the aqueous or the ethereal solvent and uninfluenced by alteration in the reaction of the fluids. Some of them are acid in constitution, and then usually they are retained in the aqueous layer when alkali is added, while the alkaloid passes in the ethereal solvent. This is the case with substances related to tannic acid, and particularly if the alkali be added in considerable excess. Frequently the preparation to be assayed contains two or more distinct colouring matters which may not be capable of separation from the alkaloids under the same conditions. Plants also contain numerous substances, some of unknown constitution, which cannot be included in the simple scheme of classification used above. The details of the processes employed in assaying galenical preparations must therefore be devised on the general lines indicated above, modified, however, by the occurrence and behaviour of the substances met with in each case. It may be necessary to transfer the alkaloid several times from one solvent to the other by changing the reaction of the fluid, and adding fresh portions of the two solvents in turn, before it is sufficiently purified, but since loss of alkaloid inevitably occurs at each transference it is desirable to limit the number of operations as far as possible. The alkaloid is usually finally separated in the ethereal layer because it can be obtained as a weighable residue by evaporation of the ethereal solvent more easily and with less risk of damage than by evaporation of the acid aqueous layer. The alkaloidal residue should be nearly colourless and in most cases distinctly crystalline. The proportion of alkaloid in the ethereal residue may sometimes be determined by titration with standard acid, and this forms a useful check upon the purity of the residue, since it excludes the chance of weighing any large quantity of non-alkaloidal material as alkaloid. In order to do this the following conditions must be satisfied:—

- (1) The alkaloid must be a sufficiently strong base to give a sharp end reaction with the acid.
- (2) The residue must not be so deeply coloured as to interfere with the colour reaction of the indicator employed.
- (3) Only one alkaloid must be present, or if more than one be present then they must all have nearly the same molecular weight and neutralisation value in relation to the standard acid.

If this last condition should not be satisfied, titration will yield results varying with the relative proportions of the various alkaloids which constitute the mixture.

**Extractum Aloes Barbadosis.** EXTRACT OF BARBADOS ALOES.

In preparing this extract the drug is exhausted by boiling water and the strained liquor evaporated to dryness at a temperature not exceeding 60° C. The extract of aloes so produced is not again completely soluble in water, although originally extracted by the solvent action of this menstruum. It appears that the material extracted by the water undergoes some change during evaporation of the liquor, so that the residue never completely redissolves, and if the process of extraction be continually repeated the total extractive matter is eventually rendered almost entirely insoluble. The change is accelerated by exposure to heat, hence the evaporation at a low temperature. [*Dose*.—1 to 4 grains.



**Extractum Anthemidis.** EXTRACT OF CHAMOMILE.

This extract is prepared by exhaustion with boiling water, but it would be preferable to use 70 per cent. alcohol. The resulting soft extract is almost entirely employed in the form of pills, resembling in that respect the extract of gentian. Since the oil of chamomile, which forms an important constituent of this drug, is inevitably dissipated during evaporation, a small quantity of oil is added towards the end of the process.

[Dose.—2 to 8 grains.

**Extractum Belladonnæ Alcoholicum.** ALCOHOLIC EXTRACT OF BELLADONNA.

This is prepared from the standardised liquid extract by evaporating four parts by measure of the latter and adding sufficient sugar of milk to produce three parts by weight of the solid extract. The proportion of alkaloids is thereby raised from 0.75 part per 100 (by volume) to 1 per cent. If the liquid extract were simply evaporated to dryness or to a firm consistence then a product would be obtained containing such a large proportion of alkaloids that its dose would be too small for practical purposes. Moreover its potency would not be constant because the ratio of alkaloids to total dissolved solids present in the liquid extract is not constant, and hence a variable weight of solid extract would be obtained by the evaporation of a given quantity of different samples. In order to reduce the dose of the extract to the desired limits,  $\frac{1}{4}$  to 1 grain, sugar of milk is employed to dilute it. The amount of this required for the purpose will depend upon the amount of total solids in the liquid extract employed and must be determined each time by experimentally evaporating a portion of the liquid extract. Having, therefore, determined the amount of sugar of milk required, the main portion of the liquid extract is evaporated and the sugar incorporated while the product is still liquid, so that it may be uniformly distributed, after which the evaporation is continued until the product, which should be a yellowish-brown slightly coherent powder, is reduced to the required weight.

[Dose.— $\frac{1}{4}$  to 1 grain.

**Extractum Belladonnæ Liquidum.** LIQUID EXTRACT OF BELLADONNA.

The liquid extract is the most important preparation of belladonna, since the remaining preparations of this drug are derived from it. The belladonna root is distributed among four percolators, and after preliminary soaking is submitted to a process of repercolation with a menstruum composed of 7 parts alcohol (90 per cent.) and 1 part water, a fluid of this composition having been shown to be capable of removing the alkaloids most easily, and unaccompanied with an undesirable amount of inert extractive matter. The percolate from the first percolator is passed through the second, from the second through the third, and from the third through the fourth. The final percolate is collected and the process discontinued when  $12\frac{1}{2}$  parts by volume have been collected from 32 parts by weight of belladonna root. The

process is stopped at this point in order to ensure that the strong percolate shall contain more than 0.75 part of belladonna alkaloids in each 100 parts by measure, and will, therefore, require dilution and not concentration in order to adjust its final volume. The average proportion of alkaloids in belladonna root is about 0.4 per cent.; two parts of such root would therefore be capable of yielding about one part by volume of extract containing 0.8 per cent. of alkaloids, on the assumption that the whole of these principles could be concentrated in this proportion of liquid extract. But by the most efficient form of extraction, viz., repercolation, it is not possible to do this without collecting a larger volume of percolate than that indicated and concentrating the weaker portions. For this reason only a limited portion of the percolate first dropping through is collected, although subsequent portions will still be found to contain alkaloids. As a matter of fact the official process removes only about 80 per cent. of the total alkaloids, but the manufacturer will express the residues in the percolators, and thus recover a great part of the alcohol and alkaloids. This expressed liquor must not be concentrated and added to the reserved portion, because evaporation will alter the appearance of the product and cause the liquid extract to change from sherry colour to brown or blackish-brown, besides violating the idea underlying the whole process, which is to produce an extract of the root containing the principles of belladonna unaltered by exposure to heat. The liquor expressed from the residues may, however, be set aside and used to commence the percolation when the next lot of liquid extract is prepared, and the alkaloids which it contains will thus go to increase the alkaloidal strength of the strong percolate then obtained. It should be observed that samples of belladonna root containing much less than 0.4 per cent. of alkaloids are unsuitable for making the liquid extract, because it will be impossible to obtain a percolate according to the process which will attain the required alkaloidal standard. The assay process having been accomplished, the percolate is diluted with more of the menstruum, so that it shall contain 0.75 parts of alkaloids—chiefly atropine and hyoscyamine—in 100 parts by volume. This is commonly spoken of as 0.75 per cent., but is not truly so, since a percentage solution implies that the parts per 100 parts are expressed in terms of the same unit. In the case of solutions, parts per 100 fluid parts will only be true percentage if the density of the solution be exactly 1.0—a condition seldom realised. The strength of solutions may, however, be shortly expressed as w/v percentage, the symbol w/v indicating parts by weight in parts by measure—*e.g.*, ounces in fluid ounces, or grammes in cubic centimetres.

ASSAY PROCESS.—To assay the strong percolate a small portion is well diluted with water and, after addition of ammonia to liberate the alka-

loids, shaken with chloroform. The dilution is necessary because chloroform mixes in all proportions with strong alcohol; moreover, belladonna alkaloids are freely soluble in that fluid, so that they are only extracted with difficulty from even moderately strong spirit by means of chloroform. The separated chloroform containing the alkaloids is next shaken with dilute sulphuric acid, by which they are converted into sulphates. These sulphates being only slightly soluble in chloroform, pass, therefore, almost entirely into the aqueous layer, in which they are freely soluble, and after a second agitation with acidulated water are practically all removed. The acid liquor is next agitated with chloroform to remove colouring matter, the alkaloidal sulphates remaining in the aqueous portion. This chloroform is rejected. When the acid liquor is, however, made alkaline with ammonia and shaken with more chloroform the conditions of solubility are reversed. The free alkaloid so produced is much more soluble in chloroform than water, and hence passes almost entirely into the chloroformic layer. By repeated agitation with fresh chloroform the extraction is rendered practically complete. The chloroform is then to be shaken with a small quantity of weak ammonia water, presumably with the intention of removing a small quantity of aqueous saline liquor adhering to the chloroform through incomplete separation after the preceding agitation. The chloroform solution thus purified is then evaporated on a water-bath and the residue dried and weighed. If the assay process has been properly conducted this residue will consist of the mixed alkaloids of belladonna associated with a very small quantity of non-alkaloidal matter not separated by the repeated shaking out with the immiscible solvents. In order to check any possible gross error in this respect the alkaloidal residue is dissolved in excess of hydrochloric acid and titrated back with soda solution. As the quantity of material dealt with is very small, decinormal acid and centinormal soda are employed in order to get the results as accurate as possible. The calculations are based upon the fact that atropine and hyoscyamine, which should constitute almost the entire amount of the alkaloidal residue, are monobasic and isomeric. One molecular weight of these alkaloids ( $C_{17}H_{23}NO_3 = 287.05$ ) will therefore combine with one molecular weight of hydrochloric acid ( $HCl = 36.19$ ).

1 litre normal HCl solution contains	36.19 grammes HCl.
∴ 1 C.c. " " " "	0.03619 " "
∴ 1 C.c. N/100 " " "	0.0003619 " "
Now 36.19 grammes HCl =	287.05 grammes $C_{17}H_{23}NO_3$ .
∴ 0.0003619 " " "	= 0.0028705 " "

From this it is seen that 1 C.c. of N/100 HCl will neutralise 0.00287 gramme of atropine or hyoscyamine. In the official process 10 C.c. of N/10 HCl is used to dissolve the residue. A portion of the acid combines with the alkaloids to form neutral hydrochlorides, and the excess of acid is then determined by N/100 NaOH. It is better to use excess



of standard acid and then titrate back with alkali, as the solution of the total alkaloids in the residue is thereby ensured. If direct titration be attempted the end reaction is not sharp because the free alkaloids are so slightly soluble in water and only dissolve as hydrochlorides when the required proportion of acid is added. If no alkaloids were present 100 C.c. of  $N/100$  NaOH would be required, since 10 C.c. of  $N/10$  HCl = 100 C.c. of  $N/100$  NaOH. The difference between 100 and the number of C.c. of  $N/100$  NaOH actually used represents, therefore, the number of C.c. of  $N/100$  HCl which have been required to combine with the alkaloids. Since each 1 C.c. of  $N/100$  HCl is equivalent to 0.00287 gramme of atropine or hyoscyamine, the weight of alkaloid in the chloroform residue can, therefore, be calculated. The weight of this residue should not differ by more than a few milligrammes from the weight of alkaloids calculated by the titration method.

**Extractum Belladonnæ Viride.** GREEN EXTRACT OF BELLADONNA.

In the case of this extract, the preparation of which has been explained in the introductory paragraph, it should be noted that in the B.P. 1885, the preparation was called simply *extractum belladonnæ*, the adjective "viride" being added in the present B.P. (1898), in order to distinguish clearly between the three official extracts of belladonna. The term "*extractum belladonnæ*" occurring in prescriptions written before the issue of the latter will therefore imply the "green" extract, and in such cases this must be dispensed. Although the dose of the alcoholic extract is now the same as that of the green extract, substitution of one for the other will cause marked alteration in the appearance of the dispensed product. The green extract of belladonna is not standardised owing probably to the lack of sufficient data to enable a satisfactory standard to be adopted. It has been shown to contain, as found in trade, a somewhat variable percentage of alkaloids—from 0.5 to nearly 2 per cent.—most samples however contain a little over 1 per cent. The influence of soil, cultivation, collection and other condition upon the yield of this extract and its alkaloidal contents, are not sufficiently well known to enable a product of uniform potency to be prepared. The only other green extract is that of *hyoscyamus*, but the extracts of *colchicum* and *taraxacum* are also inspissated juices.

[Dose.— $\frac{1}{4}$  to 1 grain.

**Extractum Cannabis Indicæ.** EXTRACT OF INDIAN HEMP.

This is prepared by exhausting Indian hemp, in coarse powder, by percolation with 90 per cent. alcohol, and subsequently concentrating at a low temperature, to form a soft extract. [Dose.— $\frac{1}{4}$  to 1 grain.

**Extractum Cascaræ Sagradæ.** EXTRACT OF CASCARA SAGRADA.

This extract, also known as *Extractum Rhamni Purshiani*, is obtained by cold percolation with water, the percolate being evaporated by the water-bath to dryness. It is used almost exclusively in pilular form, for which purpose a dry extract is most suitable, since it can be

powdered and incorporated with other ingredients. A cascara extract having a plastic pilular consistence is very tough and difficult to work, and pills made with it are very liable to flatten. [*Dose*.—2 to 8 grains.

**Extractum Cascaræ Sagradæ Liquidum.** LIQUID EXTRACT OF CASCARA SAGRADA.

In preparing this extract, also known as *Extractum Rhamni Purshiani Liquidum*, 20 parts of the drug are exhausted by maceration followed by percolation with cold water; the total percolate is evaporated to 12 fluid parts; 8 fluid parts of a mixture in equal proportions of 90 per cent. alcohol and water added to the concentrated product so as to produce 20 fluid parts of finished liquid extract. Cold water efficiently exhausts cascara sagrada, although its activity is partly, at least, due to resinous constituents. The extraction of substances of this class by water from crude drugs is sometimes possible, and appears to be due to their association with other substances in the drug in whose presence they become soluble in aqueous menstrua. The application of heat appears to have no deleterious action upon the purgative properties of cascara sagrada: hence there is no necessity to reserve the first fraction of the percolate, but the whole is evaporated together.

[*Dose*.— $\frac{1}{2}$  to 1 fluid drachm.

**Extractum Cimicifugæ Liquidum.** LIQUID EXTRACT OF CIMICIFUGA.

The liquid extract of cimicifuga, or *actæa racemosa* as it is sometimes named, is prepared on very similar lines to the extracts of coca, hamamelis, hydrastis, and jaborandi, and one fluid ounce of each corresponds to one ounce by weight of the drug from which they are prepared. The drugs are first soaked or macerated with some of the alcoholic menstruum, the strength of which is selected for each drug on the usual principle, viz., that it shall adequately exhaust the drug and yield a preparation having the desired stability and physical properties from a pharmaceutical point of view. After maceration the drug is percolated with more of the menstruum, and the first portion of the percolate, equivalent to about three-fourths of the volume of liquid extract under treatment, is collected separately and set aside. Percolation is then continued until the contents of the percolator are exhausted, and the percolate so obtained is evaporated to the consistence of a soft extract. This evaporated residue will have a relatively small bulk; it is dissolved in the first reserved portion of percolate and the volume of the mixed product adjusted by the addition of more menstruum. The first portion of percolate will naturally contain the greatest proportion of the soluble constituents of the drug: hence the deleterious action of heat is avoided, and only the weaker succeeding portions of percolate are subjected to evaporation. Moreover, since the alcoholic menstrua are really mixtures of alcohol and water, evaporation of the whole bulk of percolate would result in a liquid containing less and less alcohol as evaporation proceeded, owing to the lower boiling point of alcohol than water. A deposit would form

in the fluid as concentration proceeded, since substances extracted by the original alcoholic menstruum would not remain dissolved in the weaker alcoholic fluid resulting from evaporation. The fluid would then require filtration, and thus substances, upon whose presence the medicinal activity of the extract might depend, would be excluded from the finished fluid. The weaker percolate in the case of liquid extract of coca should be evaporated at a low temperature on account of the ease with which cocaine decomposes in solution. [*Dose*.—5 to 30 minims.]

**Extractum Cinchonæ Liquidum.** LIQUID EXTRACT OF CINCHONA.

The alkaloids in cinchona bark are only partially extracted by water or alcohol, because they are naturally combined in the bark with plant principles—probably including quinic and cinchotannic acids—with which they form sparingly soluble compounds. The official liquid extract therefore is made by maceration, and subsequent percolation, with water acidulated with hydrochloric acid, a menstruum which has a greater solvent action on the natural alkaloidal compounds of the bark, although complete extraction of the alkaloids is not effected even by that liquid. The liquors are concentrated at a temperature below that of boiling water in order to minimise the possible deleterious effect of heat, and the use of metal evaporating pans must be avoided because of the presence of free hydrochloric acid. Some glycerin is added to the menstruum, as it is useful in preventing the separation of flocculent material during concentration, besides assisting in the process of extraction. Evaporation is continued until the product may be expected to contain, approximately, the required proportion of alkaloids; this is then assayed, and its volume finally adjusted by evaporation or dilution with water so that it shall contain 5 per cent. w/v of cinchona alkaloids, after the addition of sufficient alcohol (one-eighth part of 90 per cent. alcohol) for its preservation. Since the bark employed in making the liquid extract should comply with the official requirements as to the relative proportion of quinine and cinchonidine contained in it, the assay process for this preparation need only be based upon the proportion of total alkaloids.

**ASSAY PROCESS.**—The extract is first agitated with benzolated amylic alcohol—which forms a good solvent and separates readily from the aqueous layer—and a comparatively large quantity of potassium hydroxide solution. The colouring matters are thereby retained in the aqueous layer more completely than if a small proportion of alkali were employed. A second agitation with benzolated amylic alcohol ensures the removal of the alkaloids from the alkaline liquid, and the united spirituous liquids are washed with a little water to remove adherent drops of the alkaline fluid, the aqueous washings being, of course, rejected. The washed spirituous liquids are, however, somewhat coloured, and on evaporation would not leave a residue sufficiently pure for weighing. The alkaloids are therefore removed from them as



hydrochlorides by agitation with water and diluted hydrochloric acid, most of the colouring matter being retained by the benzolated amylic alcohol. The acid aqueous solution of the hydrochlorides is then rendered alkaline with ammonia and the liberated alkaloids shaken out with chloroform, which separates readily at this stage, when only traces of impurities are present, and is more easily evaporated than benzolated amylic alcohol. The chloroformic solution is evaporated and dried at  $110^{\circ}$  C. in order to expel the last traces of moisture which are obstinately retained.

[Dose.—5 to 15 minims.

**Extractum Cocæ Liquidum.** LIQUID EXTRACT OF COCA.

This is prepared in the same manner as *Extractum Cimicifugæ Liquidum*, but the drug is employed in coarser (No. 20) powder and weaker alcohol (60 per cent.) is used.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Extractum Colchici.** EXTRACT OF COLCHICUM.

This extract is an inspissated juice, which resembles that of *taraxacum*, and differs from the green extracts of *belladonna* and *hyoscyamus*, as there is no chlorophyll to separate; hence, after the feculence due to the presence of starch or inulin has been allowed to subside, the clear liquid is at once heated to  $100^{\circ}$  C., to cause albuminous matter to separate, then strained and evaporated.

[Dose.— $\frac{1}{4}$  to 1 grain.

**Extractum Colocynthis Compositum.** COMPOUND EXTRACT OF COLOCYNTH.

In making compound extract of colocynth, a tincture of colocynth is first prepared and the alcohol removed by distillation before adding the extract of Barbados aloes, scammony resin, and soap. The powdered cardamoms are not added until evaporation is nearly completed, in order that their aroma may not be impaired. The general similarity between this extract and the pill of colocynth should be noted.

[Dose.—2 to 8 grains.

**Extractum Ergotæ.** EXTRACT OF ERGOT (ERGOTIN).

The drug is exhausted with alcohol, and the alcoholic liquid concentrated and diluted with water to precipitate inert oily and resinous substances. The filtrate is rendered acid by the addition of diluted hydrochloric acid, which causes the precipitation of some colouring matter. The liquid is then neutralised by adding the quantity of sodium carbonate equivalent to the acid previously added and evaporated to a soft extract. The neutralisation is necessary to avoid the possible action of hydrochloric acid upon the constituents of the extract during evaporation, and also because the product is often given hypodermically.

[Dose.—2 to 8 grains.

**Extractum Ergotæ Liquidum.** LIQUID EXTRACT OF ERGOT.

The ergot is crushed, and not finely powdered, in making this extract, as a powder would form a magma with water, from which it would be difficult to separate the fluid. The crushed ergot is macerated for twelve hours with two successive portions of water, the residual liquor

being expressed from the marc after the second maceration. The mixed liquors are evaporated to a low bulk, and more than half their volume of 90 per cent. alcohol is added. This comparatively large proportion of alcohol is employed on account of the facility with which an aqueous extract of ergot decomposes, the organic substances derived from this drug being particularly prone to decomposition. Ergot may be exhausted very completely and effectively by repercolation with water, but during the time necessary for the process the liquors are very apt, particularly in hot weather, to become putrid. [Dose.—10 to 30 minims.]

**Extractum Euonymi Siccum.** DRY EXTRACT OF EUONYMUS.

The euonymus bark is exhausted by treatment with 45 per cent. alcohol. The residue obtained by the evaporation of the alcohol is tough and hygroscopic, and is much more conveniently handled if obtained in the form of powder. To secure this result, it is mixed with one-fourth its weight of calcium phosphate—a non-hygroscopic substance—and dried and powdered. It must be carefully preserved from access of moisture. Sugar of milk does not form a desirable addition to this extract as it easily becomes sticky by absorption of water. [Dose.—1 to 2 grains.]

**Extractum Filicis Liquidum.** LIQUID EXTRACT OF MALE FERN.

The powdered rhizome is exhausted by percolation with ether, and the ether recovered from the percolate by distillation. The residue is a thick green oil containing several substances, the relative value of which is not sufficiently well known to enable any more exact method of preparation to be devised. [Dose.—45 to 90 minims.]

**Extractum Gentianæ.** EXTRACT OF GENTIAN.

This is prepared by infusing the drug with cold water for two hours, then boiling for fifteen minutes, and subsequently evaporating the liquid obtained, so as to produce a soft extract. The official process does not effect the removal of the whole of the bitter principle of gentian root, and the use of boiling water results in the extraction of more pectin than if cold water were used. [Dose.—2 to 8 grains.]

**Extractum Glycyrrhizæ.** EXTRACT OF LIQUORICE.

The powdered root is exhausted with cold water, the united liquids heated to 100° C., strained to remove the inert albuminous coagulum, and evaporated to a soft extract.

**Extractum Glycyrrhizæ Liquidum.** LIQUID EXTRACT OF LIQUORICE.

The root in powder is macerated and expressed with two successive portions of cold water. The united liquors are heated to 100° C. to coagulate albumin, the coagulated flocks removed by straining and the strained liquor evaporated until it has, when cold, a specific gravity of 1.200. It is preserved by the addition of one-fourth its volume of 90 per cent. alcohol, this being the minimum proportion which will effect the desired result. There is an attempt at standardisation in this extract, based upon the proportion of total extractive matter, as shown by the specific gravity of the evaporated liquor. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Extractum Hamamelidis Liquidum.** LIQUID EXTRACT OF HAMAMELIS.

This is prepared by exhausting hamamelis leaves in No. 40 powder, by percolation with alcohol (45 per cent.), and proceeding in almost the same manner as in preparing Extractum Cimicifugæ Liquidum.

[Dose.—5 to 15 minims.

**Extractum Hydrastis Liquidum.** LIQUID EXTRACT OF HYDRASTIS.

This is prepared by exhausting hydrastis rhizome in No. 60 powder, by percolation with alcohol (45 per cent.), and proceeding in almost the same manner as in preparing Extractum Cimicifugæ Liquidum.

[Dose.—5 to 15 minims.

**Extractum Hyoscyami Viride.** GREEN EXTRACT OF HYOSCYAMUS.

The explanation given concerning the green extract of belladonna applies equally well to green extract of henbane. Commercial samples appear to contain from 0.15 to 0.45 per cent. of alkaloids, mostly about 0.20 per cent., or about one-fifth the amount present in the corresponding belladonna extract.

Dose.—2 to 8 grains.

**Extractum Ipecacuanhæ Liquidum.** LIQUID EXTRACT OF IPECACUANHA.

The powdered root is soaked, and afterwards slowly percolated with 90 per cent. alcohol. When  $13\frac{1}{2}$  parts by volume of percolate from 16 parts of root have been collected, it is set aside, and percolation continued until nothing more is extracted. The residue in the percolator is then mixed with slaked lime and set aside for twenty-four hours, and percolation continued to exhaustion. The addition of lime is made at this stage, because it is found that alcohol alone will not entirely remove the alkaloids from ipecacuanha. These alkaloids comprise two, emetine and cephaëline, whose identity is well established, and possibly two others not so well known. A portion of these alkaloids is present in some form which requires the addition of lime to liberate them in an alcohol-soluble condition. The lime is not added at the beginning, because it is desirable to remove the natural constituents as far as possible by alcohol without the use of an alkali. The percolate is recovered from the last two percolates by distillation, and the residue dissolved in the strong reserved percolate. After assay the liquid is diluted with 90 per cent. alcohol so that it shall contain 2.0 to 2.25 parts of alkaloids in 100 parts by volume or 2.0 to 2.25 w/v per cent. Ipecacuanha root contains about 2 per cent. of alkaloids, so that one fluid ounce of the liquid extract is equivalent to one ounce of average quality root.

ASSAY PROCESS.—The strong liquid extract is diluted with water and the alcohol removed by partial evaporation. Solution of lead subacetate is added to precipitate colouring and other inert matters, the alkaloids remaining in solution. From the filtrate, excess of lead is removed by the cautious addition of dilute sulphuric acid which precipitates the lead as the insoluble sulphate. The filtrate from this is then rendered alkaline with ammonia and shaken with three successive portions of chloroform. The chloroformic solution is evaporated and dried at a



temperature not exceeding 80° C., because the alkaloids are very susceptible to the action of high temperatures. This process is somewhat unsatisfactory and several alternative processes have been suggested, but it has been shown (see *Pharm. Journ.* [4], 10, 176) that the official process can, with slight modification, be easily made to give satisfactory results. [*Dose.*— $\frac{1}{2}$  to 2 minims (expectorant); 15 to 20 minims (emetic).

**Extractum Jaborandi Liquidum.** LIQUID EXTRACT OF JABORANDI.

This is prepared in the same manner as *Extractum Cimicifugæ Liquidum*, but the drug is employed in coarser powder, and weaker alcohol (45 per cent.) is used. [*Dose.*—5 to 15 minims.

**Extractum Jalapæ.** EXTRACT OF JALAP.

The jalap is macerated successively in 90 per cent. alcohol and water. The two products are evaporated separately to soft extracts, which are mixed and further evaporated to a firm extract. The purgative properties of jalap are entirely due to the two characteristic resins contained in the drug, and these are extracted by the alcohol; the aqueous extract will contain only sugar, mucilage and other inert substances. The idea underlying the employment of the mixed extracts is that the water-soluble portion will subdivide the alcoholic portion and assist in its disintegration. The alcoholic portion being chiefly resinous will be insoluble in aqueous fluids, and hence pills made entirely with such substances may pass through the alimentary canal unaffected by the solvent action of the intestinal juices. Certain other highly resinous extracts—*e.g.*, Indian hemp—are open to this objection, but as a matter of practice these are usually prescribed with other things in pilular form, or in any case should be combined with a water-soluble excipient. [*Dose.*—2 to 8 grains.

**Extractum Krameriaë.** EXTRACT OF KRAMERIA OR RHATANY.

The powdered root is exhausted with cold water and the liquor evaporated to dryness. Extracts like this, which are tough in the plastic condition, are more easily manipulated in the dry state, which enables them to be used in the form of powder. [*Dose.*—5 to 15 grains.

**Extractum Nucis Vomicaë.** EXTRACT OF NUX VOMICA.

The procedure in the case of this extract is precisely the same as that described for the alcoholic extract of belladonna. As the liquid extract contains 1·5 part of strychnine per 100 fluid parts, and the solid extract is required to contain 5 cent., it follows that 50 fluid parts of the former must be concentrated to 15 parts by weight of the latter in order to secure the desired result; therefore, in the preliminary experimental evaporation the weight of the residue from one fluid ounce is deducted from 131·25 grains in order to find the amount of milk sugar necessary for the dilution because—

$$50 : 15 :: 437\cdot5 : 131\cdot25$$

This extract is about one-third weaker in total alkaloid than the corresponding extract of the B.P., 1885. [*Dose.*— $\frac{1}{4}$  to 1 grain.

**Extractum Nucis Vomicae Liquidum.** LIQUID EXTRACT OF NUX VOMICA.

The production of liquid extract of nux vomica cannot be accomplished by a process of repercolation like that of belladonna, because nux vomica cannot be so readily exhausted by a limited quantity of menstruum. The powdered seeds are therefore soaked and slowly percolated with 70 per cent. alcohol, the use of stronger alcohol being avoided because it is more liable to dissolve the fat occurring in nux vomica. The first and stronger fraction of the percolate is reserved, the remainder evaporated to a low bulk, mixed with sufficient 90 per cent. alcohol, so that the alcoholic strength of the mixture shall approximate to 70 per cent., and then added to the reserved portion. The addition of strong alcohol to the residue of the evaporation is probably made so that when the evaporated portion is added to the reserved portion, its addition shall not cause any precipitation of dissolved substances by marked alteration in the alcoholic strength of the mixed fluids. The mixture, however, is seldom clear, and after subsidence should be filtered. After assay, the liquid is diluted with 70 per cent. alcohol, so that it shall contain  $1\frac{1}{2}$  parts of strychnine in 100 parts by volume, or 1.5 w/v per cent. It should be observed that the standardisation is based upon the strychnine contents, the brucine being neglected, since its potency is only estimated at  $\frac{1}{40}$  that of strychnine.

**ASSAY PROCESS.**—The extract is first evaporated to remove alcohol; then, after suitable dilution, the alkaloids, strychnine and brucine, are liberated by sodium carbonate and shaken out with chloroform. From the chloroform they are transferred as sulphates to water. The separation of the two alkaloids is based upon the fact that strychnine forms an extremely sparingly soluble ferrocyanide, while the corresponding brucine salt is only precipitated from comparatively strong solutions, and, therefore, not at all from the dilute solution as described in the Pharmacopœia. The strychnine ferrocyanide is washed free from brucine by acidulated water, in which the precipitate is less soluble than in plain water. The washing is stopped when the bitter taste of brucine is no longer distinguishable in the wash liquor. The determination of the strychnine cannot be satisfactorily effected by drying and weighing the precipitate, since this undergoes decomposition during drying. A hole is therefore made in the point of the filter, and the moist precipitate washed into a separator by a jet of water from a washing bottle. To the strychnine ferrocyanide thus suspended in water, some solution of ammonia is added. Ammonium ferrocyanide remains dissolved in the water, from which the liberated strychnine is removed by repeated agitation with chloroform. The chloroformic solution is evaporated and the residue weighed, loss of strychnine by decrepitation being prevented by covering the evaporating basin by a watch-glass. If, however, a little amylic alcohol be added to the chloroform, the decrepitation is prevented, probably because the amylic alcohol,

having a high boiling point (about 130° C.), evaporates slowly at the last, and so prevents sudden formation of crystals. [*Dose.*—1 to 3 minims.]

**Extractum Opii.** EXTRACT OF OPIUM.

Sliced opium is exhausted by repeated maceration with cold water, and the liquors mixed, strained, and evaporated so as to obtain a residue equal to about half the weight of the opium employed. The extract is now to be assayed by the process described under "Opium," and the proportion of morphine having been thus determined, the weight of product is adjusted so that it shall contain 20 per cent. of morphine. It should be observed that in the official monograph relating to opium any suitable variety is allowed to be used for preparing the extract provided that it contains, when dry, not less than  $7\frac{1}{2}$  per cent. of morphine. The official process for the extract practically removes the whole of the morphine and most of the other alkaloids, but excludes mechanically mixed impurities—leaves, stalks, stones, etc.—wax, fat, resin, and other substances insoluble in cold water. The consistence of the extract, containing 20 per cent. of morphine according to the results of the assay, will vary considerably, owing to variation in the relative proportion of morphine and total extractive matter yielded by different samples of opium. The consistence of the finished extract is not described in the Pharmacopœia, being apparently left to the discretion of the operator: it is usually finished to the consistence of a firm extract. If a given sample of opium yield a high proportion of extractive, the extract may be solid before it is concentrated sufficiently to contain 20 per cent. of morphine, and in this case it must be combined with another extract richer in alkaloid in order to attain the desired end. On the other hand, a sample of opium may yield a relatively low proportion of total extractive, and in this case the evaporated product would be unduly soft when it contains the necessary 20 per cent. of morphine. This condition may be remedied by further concentration and addition of sufficient milk sugar to bring it to the required total weight. [*Dose.*— $\frac{1}{4}$  to 1 grain.]

**Extractum Opii Liquidum.** LIQUID EXTRACT OF OPIUM.

This is prepared by mixing  $\frac{3}{4}$  part of the standardised solid extract (containing 20 per cent. of morphine) with 16 fluid parts of water and 4 fluid parts of 90 per cent. alcohol, the latter being necessary for the preservation of the product. The mixture is allowed to stand for twenty-four hours and then filtered. Assuming that the whole of the morphine of the solid extract is dissolved by the mixture of water and alcohol, the filtrate should contain 0.75 part of morphine per 100 fluid parts or 0.75 w/v. per cent.; it will therefore contain the same proportion of morphine as tincture of opium. For 0.75 of the solid extract contains  $\frac{\frac{3}{4} \times 20}{100} = 0.15$  of morphine, and that amount of morphine in 20 fluid parts of the liquid extract  $= \frac{0.15 \times 100}{20} = 0.75$  part per 100 fluid parts.

[*Dose.*—5 to 30 minims.]



**Extractum Pareiræ Liquidum.** LIQUID EXTRACT OF PAREIRA.

The root is exhausted by maceration and percolation with boiling water.

The total solids contained in the liquor are determined by evaporating a small measured quantity on a water-bath to a firm consistence. The bulk is then evaporated, so that the concentrated fluid contains one-third its weight of such extractive, and every three volumes are brought to four by the addition of 90 per cent. alcohol to act as a preservative.

This extract is therefore standardised on total solids, on similar lines to liquid extract of liquorice. [Dose.— $\frac{1}{2}$  to 2 fluid drachms.

**Extractum Physostigmatis.** EXTRACT OF CALABAR BEAN.

The drug is exhausted by treatment with 90 per cent. alcohol, and the alcohol removed by distillation and evaporation, so as to leave a soft extract; the product is then mixed with three times its weight of sugar of milk so as to form a firm extract, the addition of the sugar of milk being necessary to reduce the strength of the finished preparation and bring its dose within suitable limits. [Dose.— $\frac{1}{4}$  to 1 grain.

**Extractum Rhei.** EXTRACT OF RHUBARB.

This is prepared by exhausting the drug with 60 per cent. alcohol and evaporating the liquid to dryness. [Dose.—2 to 8 grains.

**Extractum Sarsæ Liquidum.** LIQUID EXTRACT OF SARSAPARILLA.

The drug is extracted by repercolation with 20 per cent. alcohol in order to secure a strong final percolate. It is divided among three percolators; the percolate from the first is passed through the second, that from the second is transferred to the third percolator, so that the fluid dropping from this, having passed through three successive portions of the drug, is in a highly concentrated condition. As there is no evidence to show that the residual material, left after the collection of the volume of strong percolate described in the Pharmacopœia, contains anything worth the trouble of extraction, complete exhaustion is not carried out. To the strong percolate some glycerin is added, this addition being said to prevent the formation of a deposit in the liquid extract on keeping. [Dose.—2 to 4 fluid drachms.

**Extractum Stramonii.** EXTRACT OF STRAMONIUM.

This is prepared by exhausting the powdered seeds with 70 per cent. alcohol and evaporating to the consistence of a firm extract.

[Dose.— $\frac{1}{4}$  to 1 grain.

**Extractum Strophanthi.** EXTRACT OF STROPHANTHUS.

The powdered seeds are first deprived of their inert oil and resin, the presence of which is not desired in the extract, by treatment with purified ether; if the ether contained much alcohol and water, it would dissolve some of the active principle. The alcohol extract of the oil-free seeds is then evaporated and mixed with sufficient sugar of milk to produce 2 parts of finished extract from 1 part of seeds. The addition of sugar of milk is required in this case to bring the dose within the limits —  $\frac{1}{4}$  to 1 grain — considered

most suitable for extracts of this nature, because the alcoholic extract alone would be too powerful. Although standardisation on the amount of strophanthin present has not been adopted, owing to the absence of sufficient data, the yield of finished extract has been arranged to bear a simple relationship to the weight of seeds employed, and is therefore not influenced by the amount of total extractive yielded by different samples of drug. [*Dose*.— $\frac{1}{4}$  to 1 grain.

**Extractum Taraxaci.** EXTRACT OF TARAXACUM.

This is an inspissated juice, prepared in practically the same manner as extract of colchicum. [*Dose*.—5 to 15 grains.

**Extractum Taraxaci Liquidum.** LIQUID EXTRACT OF TARAXACUM.

This extract is prepared by the successive action of 60 per cent. alcohol and water, the alcoholic portion being simply expressed while the aqueous liquor is also concentrated before mixing. [*Dose*.— $\frac{1}{2}$  to 2 fluid drachms.

## Fel Bovinum Purificatum.

**Purified Ox Bile** or **Ox Gall** is prepared from the contents of the gall-bladder of the domestic ox, *Bos taurus*, Linné (Order Ungulata), the fresh viscid greenish or brownish-green liquid being evaporated to one-fourth its bulk, freed from mucin, etc., by precipitation with 90 per cent. alcohol, and then evaporated to the consistence of a thick extract.

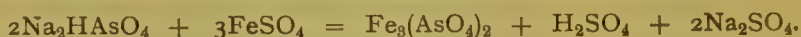
**Characters and Tests.**—Purified ox bile is a yellowish-green hygroscopic substance, with a bitter-sweet nauseous taste. It is soluble in water or in 90 per cent. alcohol, but is insoluble in ether. The absence of unpurified ox bile is shown by the aqueous solution giving no precipitate on adding 90 per cent. alcohol. The purified bile should be free from mucin and other substances insoluble in alcohol, and its aqueous solution (1 in 20 or 30) should gradually acquire a cherry-red colour (Pettenkofer's gall test)—which changes in succession to carmine, purple, and violet—on adding a drop of freshly-made syrup (sugar, 1; water, 4), followed by strong sulphuric acid, the acid being added cautiously until the precipitate at first formed is redissolved.

**Notes.**—The colour reaction produced on applying Pettenkofer's gall test is due to the presence of glycocholic and taurocholic acids, which exist in ox bile in the form of sodium glycocholate and taurocholate. In Drechsel's modification of Pettenkofer's test, syrupy phosphoric acid is first added to the ox gall, or to a concentrated alkaline solution of the biliary salts, and followed by a little cane sugar; the test-tube containing the mixture is then heated by placing it in the neck of a flask containing boiling water, and a characteristic red or reddish-violet colour will make its appearance if only traces of biliary acids be present. Other constituents of ox gall are lecithin, cholesterol, mucin, fat, soaps, and various colouring matters—bilirubin, biliverdin, bilifuscin, etc. Lecithin is a characteristic constituent of nerve substance, brain, yolk of egg, etc., which breaks up on saponification into choline, glycerophosphoric acid, stearic acid, and palmitic acid; it may therefore be regarded as glycerin, in

which the three hydroxyl hydrogens have been replaced by the phosphoric, stearic, and palmitic acid residues, the first still remaining in ethereal combination with choline. Glycocholic acid is decomposed by alkalies into cholic acid and glycocoll (amido-acetic acid), and taurocholic acid into cholic acid and taurin (amido-ethyl-sulphonic acid). [Dose.—5 to 15 grains.

## Ferri Arsenas.

**Iron Arsenate**, also known as arseniate of iron, is composed, when prepared according to the official directions, of varying proportions of ferrous arsenate  $\text{Fe}_3(\text{AsO}_4)_2$ , ferric arsenate and iron oxide. The proportion of ferrous arsenate (anhydrous), should be not less than 10 per cent. It is prepared by mixing solutions of sodium arsenate and ferrous sulphate, and then adding solution of sodium bicarbonate. The precipitate of ferrous arsenate is collected, washed, adherent moisture squeezed out, and dried at a low temperature (not exceeding  $38^\circ \text{C.}$ ). Note that sodium arsenate,  $\text{Na}_2\text{HAsO}_4$ , is an acid salt, *i.e.*, one in which the hydrogen of the arsenic acid,  $\text{H}_3\text{AsO}_4$ , is only partially replaced by the metal, whereas ferrous arsenate,  $\text{Fe}_3(\text{AsO}_4)_2$ , is a normal salt. Hence double decomposition between  $\text{Na}_2\text{HAsO}_4$  and  $\text{FeSO}_4$  results in the liberation of sulphuric acid as well as the formation of ferrous arsenate—



Since arsenate of iron is soluble in dilute acids, the sodium bicarbonate is added to neutralise this sulphuric acid and secure the complete precipitation of the iron arsenate. The ferrous arsenate becomes to a large extent oxidised during the process of washing and drying, so that the exact composition of the finished product will vary with the conditions under which it has been made, such as the time of exposure during the washing and drying, and the temperature at which the drying is accomplished.

**Characters and Tests.**—Iron arsenate is a tasteless amorphous powder of a greenish colour, insoluble in water, readily dissolved by hydrochloric acid. It affords the reactions characteristic of ferrous and ferric salts, and of arsenates. Each gramme dissolved in an excess of sulphuric acid diluted with water, should not cease to give a precipitate (or colour) with solution of potassium ferricyanide, until at least 6·7 C.c. of volumetric solution of potassium bichromate have been added, corresponding to  $12\frac{1}{2}$  per cent. of hydrous,  $\text{Fe}_3(\text{AsO}_4)_2 \cdot 6\text{H}_2\text{O}$ , or 10 per cent. of anhydrous ferrous arsenate. It should be free from sulphates, showing that the precipitated compound has been efficiently washed.

**Notes.**—In the volumetric determination for percentage of ferrous salt, the ferricyanide of potassium shows when the whole of the ferrous iron is oxidised to ferric. The solution of ferricyanide must be dilute and freshly prepared by shaking a small crystal with water, so as to obtain a very pale yellow fluid, which will not obscure the end reaction. It must be freshly prepared, because the solution of the salt on keeping suffers a partial reduction to ferrocyanide. Such solutions will therefore continue to give a blue colour with the reaction mixture after the conversion of ferrous to ferric salt. For the calculation involved in this determination, see under Ferrum Redactum.

[Dose.— $\frac{1}{16}$  to  $\frac{1}{4}$  grain.



## Ferri Carbonas Saccharatus.

**Saccharated Iron Carbonate** consists of ferrous oxycarbonate, with some ferric oxyhydrate, mixed with sugar, the ferrous salt, calculated as  $\text{FeCO}_3$ , forming about one-third of the mixture. The preparation is made by adding a solution of ferrous sulphate to a solution of ammonium carbonate in boiling water, and washing the precipitate with boiling water by decantation. If the order of mixing be reversed, the precipitated carbonate will carry down some sulphate with it. The washed precipitate is collected on a calico filter, squeezed to remove adherent water as much as possible, mixed with the sugar, and the mixture dried at a temperature not exceeding  $100^\circ \text{C}$ .

**Characters and Tests.**—Saccharated iron carbonate occurs in small coherent lumps or powder, of a brownish-grey colour, with a sweet, feebly chalybeate taste. It dissolves with effervescence in warm hydrochloric acid diluted with half its volume of water, carbon dioxide being given off. Each gramme dissolved in excess of warm concentrated phosphoric acid and diluted with water, should not cease to give a blue precipitate with solution of potassium ferricyanide until at least 29 C.c. of volumetric solution of potassium bichromate has been added. It should contain only traces of sulphates.

**Notes.**—Ferrous carbonate, like other ferrous salts, is readily oxidised by exposure to air, especially in presence of water. The directions for preparing this compound are intended to diminish, as far as possible, the extent of this oxidation, so as to obtain the maximum amount of unoxidised ferrous carbonate in the finished product. Ammonium carbonate is used in preference to the cheaper carbonates of potassium or sodium. If either of the latter be used, the precipitated ferrous carbonate carries down some alkaline salt with it, and this cannot be easily removed by simply washing. When ammonium carbonate is used, the iron precipitate is more quickly washed free from the soluble by-product. The precipitate is washed by decantation, so as to avoid the exposure to air which would occur on a filter. Boiling water obviously washes out soluble salts more thoroughly than cold; the effect of boiling, also, is to expel any oxygen dissolved in the water. It should be noted that the sugar is mixed with the moist precipitate. The addition of the sugar retards to a large extent the oxidation which would occur if the carbonate were dried alone. The finished product slowly oxidises when kept, and the oxidation is attended with a change of colour from grey-green to brown. Traces of sulphates are always found in the compound, for in order to remove these last traces prolonged washing would be necessary, and this is undesirable on account of the opportunity for oxidation it would afford. In the quantitative determination of ferrous salt by volumetric solution of potassium bichromate, the insoluble carbonate is dissolved by means of phosphoric acid. Hydrochloric or sulphuric acid produces invert sugar from cane sugar more quickly than phosphoric acid, and invert sugar is attacked by the chromic acid which is produced on the addition of bichromate solution to a liquid containing free acid. The presence of any substance having a reducing action on the bichromate would introduce an error into the process, since all the volumetric solution added would not be used up in the reaction upon which the calculation

is based, viz., the conversion of ferrous into ferric salt. It is best to avoid using heat, even when dissolving the carbonate in phosphoric acid. Compare notes on the volumetric process given under Ferri Arsenas. [*Dose*.—10 to 30 grains.

## Ferri et Ammonii Citras.

**Iron and Ammonium Citrate** is made by dissolving freshly-precipitated moist ferric hydroxide to saturation in a warm concentrated solution of citric acid. To the cooled solution, solution of ammonia is added, the liquid filtered, and the filtrate evaporated to a thin, syrupy consistence, spread in thin layers on glass plates and dried at a low temperature. The product, when dry, easily separates from the plates in the form of flakes or scales. The ferric hydroxide should be obtained by adding solution of ferric sulphate to a slight excess of diluted solution of ammonia, and thoroughly washing the precipitate till the washings are free from ammonium sulphate.

**Characters and Tests.**—Iron and ammonium citrate occurs in thin, transparent scales of a deep red colour, slightly sweetish and astringent in taste. It feebly reddens litmus, owing to partial dissociation of the compound during evaporation and consequent loss of ammonia; soluble in half its weight of water, and almost insoluble in 90 per cent. alcohol. When incinerated, with free access of air, it leaves 31 to 32 per cent. of ferric oxide, which is not alkaline to litmus. Alkalinity of ash indicates the presence of fixed alkali, which occurs if the ferric hydroxide used in making the compound be prepared by means of potassium or sodium hydroxide instead of ammonia. So prepared, the ferric hydroxide carries down and retains some alkaline salt, which naturally renders the ash alkaline. Heated with solution of potassium hydroxide, it evolves ammonia and deposits ferric hydroxide; the alkaline filtrate from which the iron has been removed does not give a crystalline precipitate when a slight excess of acetic acid is added. In this test, after treatment with potash solution, the filtrate should contain nothing but potassium citrate, with excess of potassium hydroxide, the ammonia having been expelled and the iron precipitated as hydroxide. Formation of a crystalline deposit in this filtrate, when it is acidified with acetic acid, would indicate substitution of (the usually cheaper) tartaric acid for citric acid in manufacture. Treatment with potash would then result in the filtrate containing potassium tartrate, and on the addition of excess of acetic acid the sparingly soluble acid tartrate (cream of tartar) would be precipitated—



**Notes.**—The “scale” compounds of iron possess a special value in medicine, since they are less astringent than the ordinary salts of iron and also afford a means of giving that metal in neutral or alkaline solution. The behaviour of iron and the other metals of the same group towards certain organic hydroxy-acids (and other organic bodies containing hydroxyl groups, *e.g.*, sugar and glycerin) has an important bearing upon practical analysis, because in presence of these substances the hydroxide is not precipitated on the addition of ammonia, soluble double compounds being produced. Hence the

necessity, in the course of qualitative analysis for the detection of metals, for precipitating the iron as sulphide with ammonium sulphide, unless the absence of those organic substances has been previously determined. Note that in preparing the ferric hydroxide the persulphate solution is poured into the excess of ammonia. If the order be reversed some oxysulphate of iron is carried down with the ferric hydroxide, and interferes with the brilliancy of the scales. In these scale compounds the iron appears to enter into and form part of a complex acidulous radical, probably by replacing one or more hydrogen atoms of the hydroxyl groups. This explains why the iron in these compounds does not afford some of the reactions shown by ordinary iron salts, in which the iron is the basylous radical. The same behaviour, in a more marked degree, is shown by iron in the complex ferro- and ferri-cyanic compounds.

[Dose.—5 to 10 grains.

### Ferri et Quininæ Citras.

**Iron and Quinine Citrate** is prepared by dissolving freshly precipitated ferric hydroxide in excess of citric acid and then adding quinine, freshly precipitated by addition of ammonia to an acid solution of quinine sulphate. Solution of ammonia is then added to the liquid in small portions, the quinine precipitated after each addition being thus allowed to redissolve, and the total quantity of ammonia being such as to leave the liquid slightly acid. The solution is finally evaporated and "scaled" as described under "Ferri et Ammonii Citras."

**Characters and Tests.**—Iron and quinine citrate occurs in thin scales of a greenish golden-yellow colour, somewhat deliquescent. Soluble in half its weight of cold water. The solution is very slightly acid, and yields precipitates which are reddish-brown (ferric hydroxide) with solution of potassium hydroxide, white (quinine) with solution of ammonia, blue with both ferro- and ferri-cyanide of potassium (showing that both ferrous and ferric salts are present) and greyish-black (mixture of white quinine tannate with black iron tannate) with solution of tannic acid. Iron and quinine citrate has a bitter chalybeate taste. When incinerated, with free access of air, it leaves a residue which, when moistened with water, is not alkaline to test-paper (absence of fixed alkali—compare tests for Ferri et Ammonii Citras). Five grammes dissolved in 45 C.c. of water and treated with a slight excess of ammonia should yield a white precipitate of quinine, which may be dissolved out by repeated treatment of the liquid with ether. The ethereal solutions evaporated, leave a residue which, dried at 120° C, should weigh 0.75 gramme (= 15 per cent. quinine). Three portions of ether, about 20 C.c. each, should be sufficient for the removal of the quinine. The dried residue should be almost entirely soluble in a little "purified ether" showing that it is quinine, and not one or other of the cheaper cinchona alkaloids which are much less soluble in ether than quinine. This alkaloidal residue should also leave but a minute residue on incineration, and when neutralised by sulphuric acid it should answer to the characters and tests of quinine sulphate.

**Notes.**—The difference in colour between these scales and those of the citrate of iron and ammonium is probably connected with the presence in the

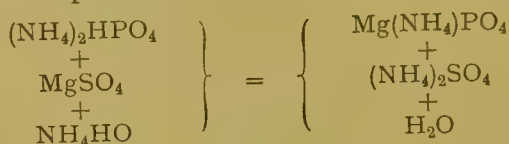


former of some ferrous salt (see the tests with potassium ferro- and ferri-cyanide). In making the green quinine compound the ferric hydroxide is dissolved in excess of citric acid, which reduces some ferric to ferrous salt. In making the red scales of citrate of iron and ammonium, excess of ferric hydroxide is employed and no reduction takes place. [*Dose*.—5 to 10 grains.]

## Ferri Phosphas.

**Iron Phosphate** is a powder composed of ferrous phosphate, ferric phosphate, and some oxide of iron. The ferrous salt calculated as  $\text{Fe}_3(\text{PO}_4)_2, 8\text{H}_2\text{O}$  should constitute 47 per cent. of the substance. It is prepared by precipitating ferrous phosphate from a solution of ferrous sulphate by the addition of sodium phosphate and bicarbonate in a manner similar to that described under "Ferri Arsenas." Ferrous phosphate, like ferrous arsenate, undergoes partial oxidation during the operations of washing and drying.

**Characters and Tests.**—Iron phosphate is a slate-blue amorphous powder, insoluble in water, soluble in hydrochloric acid. The acid solution yields blue precipitates with both ferro- and ferri-cyanide of potassium, indicating the presence of both ferrous and ferric salts. If excess of ammonia be added to the solution in hydrochloric acid, the iron phosphate is reprecipitated, but if tartaric acid be added before the ammonia, reprecipitation does not occur, a soluble "scale compound" being formed (see notes on Ferri et Ammonii Citras). If now to this alkaline liquid (which contains ammonio-tartrate of iron, ammonium chloride and phosphate, and free ammonia) solution of magnesium ammonio-sulphate be added, a white granular precipitate of magnesium ammonium phosphate is produced.



One gramme dissolved in hydrochloric acid should require for complete conversion into ferric salt 28.2 C.c. of the volumetric solution of potassium bichromate, the termination of the reaction being recognised in the manner described under "Ferri Arsenas," since—

$$\begin{array}{rcl} 1 \text{ C.c. N/10 } \text{K}_2\text{Cr}_2\text{O}_7 & = & 0.0166 \text{ gramme } \text{Fe}_3(\text{PO}_4)_2, 8\text{H}_2\text{O} \\ 28.2 \text{ C.c. } & " & " & " & " & " \\ & & i.e., 46.8 \text{ per cent.} \end{array}$$

Iron phosphate should yield no characteristic reaction with the tests for arsenium.

**Notes.**—The formation of a precipitate of magnesium ammonium phosphate, under suitable conditions, forms one of the characteristic tests for phosphates. Arsenates also give a precipitate, of similar appearance, of magnesium ammonium arsenate ( $\text{MgNH}_4\text{AsO}_4$ ). Arsenates and phosphates both give yellow precipitates with the ammonium molybdate test, the reaction, however, occurring more quickly and at a lower temperature in the case of phosphates. The colour of the silver salts and the reaction with hydrogen

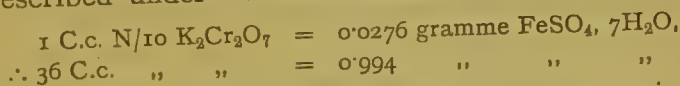
[Dose.—5 to 10 grains.

Ferri Sulphas.

**Ferrous Sulphate**,  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ , may be prepared by the action of diluted sulphuric acid upon metallic iron—



**Characters and Tests.**—Ferrous sulphate occurs in oblique rhombic prisms, of a pale bluish-green colour and astringent taste; insoluble in alcohol, soluble in less than two parts of water and giving a clear solution free from a rusty deposit, which only appears in a freshly-made solution when the salt contains oxysulphate. It affords the reactions characteristic of ferrous salts and of sulphates. One gramme dissolved in water acidulated with sulphuric acid requires for complete conversion into ferric sulphate 36 C.c. of volumetric solution of potassium bichromate, the end of the reaction being recognised in the manner described under "Ferri Arsenas."

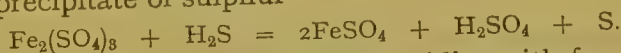


Ferrous sulphate should be free from copper, zinc, potassium, sodium and ammonium. Its solution in water should not give any precipitate with hydrogen sulphide.

**Notes.**—The hydrogen sulphide test is described in the official monograph as indicating “absence of ferric compounds, etc.” Hydrogen sulphide does not precipitate ferrous sulphide from neutral solutions of ferrous salts, because ferrous sulphide is soluble in the free acid which would be formed in the reaction—



In the case of ferric salts also, no iron sulphide is precipitated, but reduction to ferrous salt is brought about by the hydrogen sulphide with consequent production of a whitish precipitate of sulphur—



Aqueous solutions of ferrous sulphate rapidly oxidise with formation of a rusty deposit of oxysulphate. Ferrous ammonium sulphate  $\text{FeSO}_4$ ,  $(\text{NH}_4)_2\text{SO}_4$ ,  $6\text{H}_2\text{O}$  is much more stable, and is used for standardising the volumetric solution of potassium bichromate. [*Dose*.—1 to 5 grains.]

Ferri Sulphas Exsiccatus.

**Exsiccated Sulphate of Iron**, also known as dried sulphate of iron, is produced by heating the green crystals of ferrous sulphate in a porcelain or iron dish to a temperature of  $100^{\circ}\text{C}$ . until aqueous vapour ceases to be given off. The residue, which consists of the salt  $\text{FeSO}_4\text{H}_2\text{O}$  and some ferric oxysulphate produced by oxidation during the application of heat, weighs about 60 per cent. of the original salt, for—



**Characters and Tests.**—Exsiccated sulphate of iron is a nearly white powder, slowly but entirely soluble in water. This solution yields green crystals of  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  on evaporation. One gramme dissolved in water, acidulated with sulphuric acid should require at least 54.6 C.c. volumetric solution of potassium bichromate for complete oxidation to ferric sulphate, the termination of the reaction being indicated in the manner described under “Ferri Arsenas.” This requirement indicates at least 92.18 per cent. (B.P. states  $92\frac{1}{2}$  per cent.) of the salt  $\text{FeSO}_4 \cdot \text{H}_2\text{O}$ , for—

$$\begin{array}{rcl} 1 \text{ C.c. N/10 } \text{K}_2\text{Cr}_2\text{O}_7 & = & 0.0169 \text{ gramme } \text{FeSO}_4 \cdot \text{H}_2\text{O}, \\ \therefore 54.6 \text{ C.c. } & & = 0.9218 \text{ } \end{array}$$

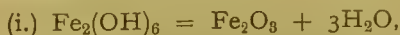
**Notes.**—The crystals of ferrous sulphate lose six-sevenths of their water of crystallisation at  $100^\circ \text{C}$ ., the remainder of the water not being expelled until that temperature is exceeded. If, however, the temperature should exceed  $149^\circ \text{C}$ ., the salt would be decomposed, its colour then changing from greyish-white to brownish. [*Dose.*— $\frac{1}{2}$  to 3 grains.]

## Ferrum.

**Iron**, for the manufacture of medicinal preparations, is used in the form of fine annealed wire (about 0.1 Mm. diameter), No. 35 gauge, or wrought iron nails, free from rust.

## Ferrum Redactum.

**Reduced Iron** consists of a mixture of iron and iron oxides in the form of a fine powder, which should contain at least 75 per cent. of iron in the condition of metallic iron. It is made by heating ferric hydroxide to dull redness in a tube, and passing over it a stream of dry hydrogen until the gas issuing from the end of the tube is free from water vapour. The tube is then allowed to cool, a slow stream of hydrogen being maintained, until it has attained the ordinary temperature of the air. If the reduced iron be exposed to air during cooling it will recombine with oxygen to form the oxide  $\text{Fe}_3\text{O}_4$ . In this process the hydroxide first loses water and is converted into oxide—



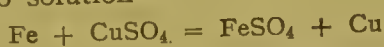
and then, at a dull red heat, the oxide is reduced to metal by the hydrogen.



**Characters and Tests.**—Reduced iron is a fine greyish-black powder, strongly attracted by the magnet, and producing metallic streaks when rubbed with firm pressure in a mortar. It should be free from arsenium and dissolve in hydrochloric acid with the evolution of hydrogen, any smell of hydrogen sulphide indicating the presence of iron sulphide. Iron sulphide might be derived from two sources incidental to the method of manufacture; (1) use of impure hydrogen containing sulphur compounds, which would be taken up by the iron during the process of reduction, and (2) employment of ferric oxide containing oxysulphate, which would be reduced by the hydrogen to sulphide. If the ferric hydroxide be made from solution of ferric sulphate, it is difficult to wash away entirely the oxysulphate which is carried down by the hydroxide. The solution of reduced iron in hydrochloric acid gives a light



blue precipitate with potassium ferrocyanide, because any ferric salt resulting from the solution of ferric oxide ( $\text{Fe}_2\text{O}_3$ ) or ferroso-ferric oxide ( $\text{Fe}_3\text{O}_4$ ) would be reduced to ferrous salt by the hydrogen evolved during the solution of the metallic iron. The quantitative determination of the metallic iron in reduced iron is made in the following manner:—0.25 gramme of reduced iron is added to a hot solution of 1 gramme copper sulphate in 15 C.c. of water. The metallic iron replaces an equivalent quantity of copper which is precipitated, while ferrous sulphate goes into solution—



The oxides of iron are not acted upon by the copper sulphate. The mixture is agitated for ten minutes, to complete the reaction, in a well-closed flask, so as to limit oxidation as much as possible. It is then rapidly filtered, and the filtrate, containing some copper sulphate, which does not interfere with the reaction, acidulated with sulphuric acid, should require at least 33.7 C.c. of volumetric solution of potassium bichromate for complete conversion to ferric sulphate, the end of the reaction being indicated as described under "Ferri Arsenas."

Since 1 C.c. N/10  $\text{K}_2\text{Cr}_2\text{O}_7$  = 0.00556 gramme Fe  
 33.7 C.c. " " " = 0.1874 " "  
*i.e.*—0.1874 gramme Fe in 0.25 reduced iron, or 74.96 per cent.

**Notes.**—The reaction between ferric oxide and hydrogen is a good example of a reversible chemical reaction, since steam passed over heated iron forms oxide of iron and hydrogen and the equation may be written  $\text{Fe}_2\text{O}_3 + 3\text{H}_2 \rightleftharpoons 2\text{Fe} + 3\text{H}_2\text{O}$ . If ferric oxide be heated in a closed tube containing hydrogen the reaction shown by the equation proceeds to a limited extent and then stops, a condition of equilibrium being attained owing to the retention of the water vapour and the consequent reversal of the first reaction. The extent and direction in which the reaction proceeds is chiefly conditioned by the relative amount of oxide and hydrogen present. But in the process described in the Pharmacopœia a current of dry hydrogen is passed continually over the oxide; the water formed is thus swept out of the tube by the excess of hydrogen and the reduction of the oxide proceeds. On the other hand, if steam be passed over heated iron, the hydrogen liberated by the oxidation of the metal is carried away by the excess of steam, and the oxidation of the iron proceeds continuously. Theoretically it should be possible to produce reduced iron containing nothing but metallic iron, but on the manufacturing scale it seldom contains more than 90 per cent. Moreover, the iron slowly oxidises when kept, but there should be no difficulty in obtaining samples well above the official standard. If the oxide be overheated during manufacture the resulting preparation is coarse grained and appears to have undergone incipient fusion: in such case more prolonged digestion in the copper sulphate will be required in order that the metallic iron may displace its equivalent of copper from the copper sulphate. Samples like these should be rejected, even if they contain the required percentage of metallic iron, because they do not comply with the official description—"a fine greyish-black powder"—the condition of fine powder being desirable because it facilitates solution by the action of the gastric juice and consequent absorption. Some samples sold as reduced iron appear to be nothing more than the Ferrum



## Ferrum Tartaratum.

**Tartarated Iron** is prepared by mixing moist freshly precipitated ferric hydroxide with potassium hydrogen tartrate and allowing the mixture to stand twenty-four hours. Water is then added, the mixture digested at 60° C., and filtered from undissolved hydroxide. The filtrate is evaporated at a low temperature and "scaled."

**Characters and Tests.**—Tartarated iron occurs in thin transparent scales of a deep garnet colour, somewhat sweetish and astringent in taste, soluble in water and sparingly soluble in 90 per cent. alcohol. The aqueous solution, when acidulated with hydrochloric acid, affords a copious blue precipitate with potassium ferrocyanide but none, or only a greenish turbidity, with ferricyanide, showing that the iron exists entirely or mainly in the ferric state. When the salt is boiled with solution of sodium hydroxide a reddish precipitate of ferric hydroxide separates and the filtrate will contain sodium and potassium tartrates with the excess of sodium hydroxide. If this filtrate be slightly supersaturated with acetic acid, it deposits, on cooling, a crystalline precipitate of acid potassium tartrate—



The reaction is rendered more delicate by the addition of alcohol in which acid potassium tartrate is less soluble than in water. By incinerating 10 grammes a residue of ferric oxide mixed with potassium carbonate is obtained. If this be washed with water the potassium carbonate is dissolved and the residual ferric oxide after re-ignition to remove water should weigh 3 grammes.

**Notes.**—The formation of a precipitate of acid potassium tartrate as described above, and the alkaline ash, distinguish tartarated iron from the citrate of iron and ammonium. Refer to the notes on the latter.

[Dose.—5 to 10 grains.]

## Ficus.

**Figs** are the dried, fleshy receptacles of *Ficus Carica*, Linné (N.O. Urticaceæ), a native of Persia and neighbouring countries, but now cultivated in most warm and temperate climates. By the abnormal growth of lateral shoots, green, hollow, pear-shaped receptacles are produced, each of which has a small aperture closed by bracts, and bears numerous small flowers on its inner fleshy walls. As ripening proceeds, the latex or milky juice disappears from the laticiferous vessels contained in the walls, sugar is formed, and the receptacles become pulpy, sweet, and agreeable to the taste. They are then collected and, after being dried in the sun, constitute the figs of commerce. The so-called "natural" figs have been packed loose, and retain their original shape, more or less; "pulled" figs are such as have been pressed and kneaded to make them supple and have a translucent "skin"; they are packed in small boxes for exportation. The pressed figs alone are official.

**Characters.**—The fig consists of the enlarged, hollow, succulent receptacle (syconus), bearing very numerous minute one-seeded fruits (achenes) on its



inner surface. As met with in commerce, figs are compressed, irregular in form, soft, tough, brownish, or yellowish, with a sweet taste and pleasant fruity odour.

**Notes.**—Dried Smyrna figs are most esteemed, being thin-skinned, soft, and luscious; Greek figs are thicker-skinned, tougher, and less pulpy. Figs contain more than 50 per cent. of sugar (dextrose), and stellate crystals of calcium oxalate occur in small quantity, together with gum, fat, and salts.

## Filix Mas.

**Male Fern** consists of the rhizome of *Aspidium Filix-mas*, Swartz (N.O. Filicineæ), one of the commonest indigenous British ferns. It produces a circular tuft of fronds, which attain a height of 30 to 90 Cm., and have a pinnately divided lamina, while the petiole (rachis) bears numerous brown scarios scales, especially on the lower part. The rhizome is collected late in the autumn—when it is richest in filicic acid—and dried, after being divested of rootlets, leaves, and dead portions.

**Characters.**—Male fern usually occurs in pieces from 7·5 to 15 Cm. in length and from 2 to 2·5 Cm. in diameter. The rhizome proper constitutes only about half the thickness of each piece, the rest being made up by the dark-brown bases of the petioles that have been left attached. Those are usually about 25 Mm. in length, from 6 to 12 Mm. in thickness, hard, persistent, curved and angular. They are also more or less densely covered with numerous dry brown membranous scales, the marginal cells of which are seen under the microscope to be prolonged at intervals into simple hair-like processes, each consisting of two parallel and contiguous cells; glandular hairs are usually absent, though sometimes there are two at the base of the scale. The bases of the petioles should be green internally and exhibit in smoothed transverse sections from seven to nine fibro-vascular bundles (steles), arranged in a diffuse circle. The brown rhizome should also be green internally, and exhibit in transverse section about as many principal steles as the petioles. Peculiar secreting cells occur in intercellular spaces in the parenchymatous tissue of the rhizome and petioles. The drug possesses a faint disagreeable odour, and a taste which is sweetish and astringent at first, but subsequently bitter and nauseous. The same odour and taste characterise the oleo-resin, or liquid extract of male fern, obtained from the drug by extraction with ether.

**Notes.**—The distinctive characters of male fern are the presence of secreting cells in the parenchymatous tissue, the number of bundles or steles at the base of the petiole, and the absence of glandular hairs from the margins of the scales. The lady fern, *Athyrium filix-fœmina*, has no secreting cells, and only two large bundles in the base of the petiole; the shield fern, *A. spinulosum*, possesses glandular secreting cells on the margins of the scales. The chief active constituent of male fern is about 5 per cent. of filmarone, a yellow, amorphous substance of acid nature, to which the vermifuge action of the drug

appears to be due. Other constituents of the drug are filicic acid, aspidinol, flavaspidic acid, albaspidin, filicitannic acid, starch, and about 6 per cent. of fixed oil. Filmarone is insoluble in water, but readily soluble in acetone, chloroform, or ether, and sparingly soluble in alcohol or petroleum spirit. When dissolved, it slowly decomposes into filicic acid and aspidinol, both of which are comparatively inert. Filicic acid also tends to become converted into its inactive, crystalline anhydride filicin. Some of the substances which have been isolated from male fern appear to be formed in the peculiar secreting cells previously referred to, and they are present in the ethereal extract of the drug.

## Fœniculi Fructus.

**Fennel Fruit** is obtained from *Fœniculum capillaceum*, Gilibert (N.O. Umbelliferæ), a plant which is apparently indigenous to the countries bordering on the Mediterranean, and is cultivated in France, Germany (Saxony and Thuringia), Russia, Galicia, Roumania, India, Japan, Persia, &c. The dried ripe fruit collected from cultivated plants is alone official. That grown in Saxony is the largest and best, and the official description is apparently based on the characters of Saxon fruit; but the Russian, Galician, and Roumanian varieties are also suitable for pharmaceutical purposes, though not all in accordance with official requirements as to size.

**Characters.**—Fennel fruit should be from 5 to 10 Mm. in length and about 3 Mm. in diameter, oblong in shape, more or less curved, and capped by a conspicuous stylopod and two styles. The fruit is glabrous, greenish-brown or pale yellowish-brown in colour, and consists of two mericarps united and attached to a pedicel about the same length as the fruit. The mericarps are easily separated and each one bears five paler primary ridges which are so prominent as to give the fruit a winged appearance. In transverse section a mericarp exhibits six large vittæ—four on the dorsal and two on the commissural surface. The aromatic odour and sweet, agreeable, aromatic taste of the fruit are due to the volatile oil it contains.

**Notes.**—The distinctive characters of fennel fruit are the very prominent ridges, large vittæ, and characteristic odour and taste. It varies in size and colour according to its place of origin. Thus, Saxon fennel is from 8 to 10 Mm. long, 3 Mm. wide, and greenish-brown or yellowish-brown in colour; the Galician variety is only 5 to 6 Mm. long, and from 1 to 1.5 Mm. wide; Russian fennel is from 4 to 5 Mm. long 1.5 to 2 Mm. wide, and usually brownish-green in colour. Those three varieties of fruit yield between 4 to 5 per cent. of volatile oil which contains about 18 to 20 per cent. of fenchone and differs only as regards the three varieties in the proportion of anethol present. The Japanese fruit is less pungent, as it contains only 2 to 3 per cent. of volatile oil; the fruit is also very small, pale greenish-brown in colour, from 3 to 4 Mm. long, and 2 to 3 Mm. wide. French sweet fennel is 7 to 8 Mm. long, 2 to 3 Mm. wide, pale yellowish-green in colour, and yields rather more than 2 per

cent. of volatile oil which contains little or no fenchone, though it is richer in anethol than other varieties. French bitter fennel is from 4 to 5 Mm. long, 2 Mm. wide, and darker in colour than the sweet variety. The oil obtained from the Persian fruit is also very rich in anethol, though containing only 3 per cent. of fenchone; the fruit is very green, from 6 to 7 Mm. long and less than 2 Mm. wide. Indian fennel fruit is from 6 to 7 Mm. long, browner in colour than usual, and contains less than 1 per cent. of volatile oil. The chief constituents of the volatile oil obtained from fennel fruit are fenchone (fenchol) and anethol, while dextro-pinene, dipentene, phellandrene, and limonene have been found, though not all in the same specimens of oil. Fenchone is a ketone and an isomer of camphor, possessing a pungent camphoraceous odour and a bitter taste; anethol, of which good oils contain from 50 to 60 per cent., is also the chief constituent of anise oils and is present in all fennel oils, but in greatest proportion in those oils which contain least fenchone. Pinene is present in all fennel oils, and phellandrene is found in appreciable quantity in the French and Indian varieties. Other constituents of fennel fruit are fixed oil, sugar, and mucilage.

## Galbanum.

**Galbanum** is a gum-resin obtained from *Ferula galbaniflua*, Boissier and Buhse (N.O. Umbelliferæ), and other species. It is believed to be produced by two plants growing in Northern Persia—*F. galbaniflua*, and *F. galbaniflua*, var. *β-ancheri*, Boissier; *Ferula Schair*, Borszczow, a plant growing on the confines of Siberia and Turkestan is also stated to yield galbanum. Numerous schizogenous ducts, which secrete a milky gum-resinous juice, occur in the cortical portion of the stem and root of the plants, and some of the juice exudes naturally in the form of tears. But the major portion of the gum-resin is understood to be obtained by removing the stem near the crown and collecting the juice as it exudes and hardens, successive slices of the root being removed at intervals of a few days. All varieties of commercial galbanum appear to come from or through Persia, but the gum-resin is imported by way of the Levant, Bombay, and Russia. Two chief varieties of galbanum are known in commerce—Levant and Persian. The so-called Levant galbanum may occur (1) in opaque or translucent tears; (2) in small lumps mixed with pieces of stalk and, sometimes, fruits; (3) in sticky masses containing slices of root, and consisting of small translucent yellowish fragments mixed with larger soft bluish or greenish portions. All three kinds have a decided musky odour, and the last-described is the kind usually met with in commerce; it is probably exported from Persia to India, and thence finds its way to Europe by way of Bombay, Egypt, or Turkey. Persian galbanum, definitely known by that name, may occur (1) as a brownish or reddish-brown liquid of the consistence of Venice turpentine; or (2) in masses of small sticky tears with a varnished appearance, mixed with fragments of stem, fruit-stalks, etc. Those two kinds have a distinct turpentine-like odour, in addition to that characteristic of the galbanum usually met with; they appear to be exported from Persia to India, but some Persian galbanum also reaches Russia by way of Astrachan and Orenburg.



**Characters and Tests.**—Galbanum should be in distinct tears or in irregular masses of agglutinated tears, both tears and masses varying in colour from opaque yellowish or orange-brown to translucent bluish-green. The latter appears to be the original colour of the gum-resin, but it becomes opaque and darker coloured with age. The tears are rounded or irregular in form, sometimes rough and dirty on the surface, and, on the average, about the size of a pea, though sometimes much larger. In cold weather they are hard and brittle, breaking easily with an irregular granular fracture and then usually appearing opaque, yellowish and soft internally, though sometimes translucent and of a bluish-green colour. The tears soften as the temperature rises, the heat of the hand sufficing to render them ductile and sticky. When agglutinated in masses, they are imbedded in a brownish mass and mixed with various foreign substances, including transverse slices of root. Similar slices, about an inch or more in diameter, may be found mixed with galbanum in tears; they frequently bear on one side some of the gum-resin which has dried there on exuding from the freshly cut surface of the root. The characteristic bitter and unpleasant taste of galbanum is due to the resin it contains; the equally characteristic aromatic odour is due to volatile oil, umbelliferone, and resin. The presence of umbelliferone is proved by heating a small fragment of the gum-resin to redness in a dry test-tube, so as to liberate the umbelliferone from its combination with the resin, and treating the contents of the tube, after cooling, with boiling water; the resulting solution, when largely diluted and rendered alkaline by adding solution of ammonia, should exhibit the same peculiar blue fluorescence as is produced in the case of asafetida.

**Notes.**—Good qualities of galbanum should contain not more than 10 per cent. of moisture, and should yield about 60 per cent. to alcohol, while leaving not more than 7 per cent. of ash on incineration. It differs from ammoniacum in containing umbelliferone, the lactone of umbellic acid, which is present both free and in combination, the purified resin being stated to contain about 0.25 per cent. of free umbelliferone and 20 per cent. of combined umbelliferone. The resin, of which the drug contains from 60 to 66 per cent., yields an alcohol—galba-resinotannol—and umbellic (dioxycinnamic) acid when boiled with solution of potassium hydroxide. Other constituents of galbanum are 15 to 20 per cent. of gum and 5 to 10 per cent. or more of a colourless or yellowish volatile oil (specific gravity, 0.910 to 0.940) containing pinene and cadinene, which can be separated by distillation with water. When submitted to dry distillation the resin yields a thick oil of a brilliant blue colour, with an aromatic odour and a bitter acrid taste. That oil deposits crystals of umbelliferone on cooling, and when submitted to fractional distillation yields, first, a greenish portion, and then a product agreeing in characters with the blue oil obtained from the flowers of *Matricaria Chamomilla*. [Dose.—5 to 15 grains.]

## Galla.

**Galls** are excrescences on *Quercus infectoria*, Olivier (N.O. Cupuliferæ), which results from puncture of the bark of young twigs by the female of *Cynips Gallæ tinctoriæ*, Olivier (Order Hymenoptera), and subsequent deposition

of eggs by that insect. Galls are formed on many plants which are thus punctured by insects for the purpose of depositing their eggs, but only "Aleppo" galls, formed upon the particular plant named, and produced by the insect specified, should be used for medicinal purposes. The young twigs are pierced by the gall wasp with its ovipositor nearly to the cambium, and one or more eggs are deposited. Those increase in size, and probably secrete a particular fluid which promotes the formation of a gall. As a result abnormal development of the vegetable tissues takes place, the eggs or larvæ hatched therefrom becoming completely enclosed in a nearly spherical mass, which projects from the twig and furnishes the larvæ with a supply of starchy and other nutritive material. The growth of the gall continues only so long as the egg or larva lives, or until the latter reaches maturity and passes into a chrysalis, from which the fully developed gall-wasp emerges and escapes into the air through a hole bored with its mandibles in the side of the gall. The best Aleppo galls are those collected before the insects escapes. They are collected in Asiatic Turkey, particularly in the province of Aleppo, but they are also exported from Persia and Greece. When not perforated the galls are of a dark olive green colour, comparatively heavy, and known in commerce as "blue" or "green" galls; if collected after the insects have escaped, the galls are of a paler yellowish-brown hue, lighter in weight, and are known in commerce as "white" galls. The latter are less esteemed, being supposed to contain less gallotannic acid than the "blue" or "green" galls, which alone are official, though there is no definite information on that point.

**Characters.**—Aleppo galls of good quality are hard and heavy, dark bluish-green or olive-green in colour, nearly spherical (sub-globular) in shape, and from 12 to 18 Mm. or more in diameter. They are tuberculated on the surface, the short, bluntly pointed projections being most numerous on the upper portions; both projections and intervening spaces are smooth. On breaking the gall it appears yellowish or brownish-white within, and there is usually a small cavity containing the remains of a larva or gall-wasp. Galls have no marked odour, but they are characterised by their taste—due to the tannic acid present—which is intensely astringent, but followed by a slight sweetness.

**Notes.**—Inferior galls are spongy, light, and of a whitish colour, while English oak-galls or "oak apples" are smooth, globular, brown, usually perforated, and much less astringent than Aleppo galls, containing only 15 to 20 per cent. of gallotannic acid. Chinese galls—produced by *Aphis chinensis*, Bell., on *Rhus semialata*, Murray (N.O. Anacardiaceæ)—are also of commercial importance, but they are employed chiefly for the manufacture of tannic and gallic acids, pyrogallol, ink, etc. They are not spherical, but of extremely diverse and irregular form, with a covering of thick, grey, velvety down masking their reddish-brown colour; they contain about 70 per cent. of gallotannic acid. Aleppo galls contain from 50 to 70 per cent. of gallotannic acid and 2 to 4 per cent. of gallic acid, together with ellagic and cyclogallipharic acids, sugar, and starch.

## Gelatinum.

**Gelatin or Glutin** is an albuminoid substance obtained from animal tissues—skin, tendons, ligaments, and bones—by the action of boiling water. It does not exist ready formed in the tissues, but results from the prolonged action of the boiling water upon the collagen in the cartilages. The aqueous solution sets on cooling into a jelly, but if the water be driven off a thick syrupy liquid results which forms horny sheets on cooling and drying by exposure to the air. The crude product so obtained is known as glue, but by purification the odour and colour are removed, and commercial gelatin—the better varieties of which are known as “French gelatin”—is obtained.

**Characters and Tests.**—Gelatin occurs in translucent and almost colourless sheets or shreds. When dissolved in 50 parts of hot water it should form an inodorous solution which will solidify to a jelly on cooling. It is insoluble in 90 per cent. alcohol, ether, or chloroform, but dissolves in acetic acid, being thus distinguished from chondrin—a substance obtained from hyaline cartilage by boiling—which does not produce a good jelly and is precipitated from aqueous solutions by acetic acid. Aqueous solutions of gelatin are distinguished from solutions of proteids, to which gelatin is closely allied, by yielding no precipitate with solutions of any acid except tannic acid, the reaction in the latter case being the same as that which occurs during the conversion of hides into leather, and being utilised, conversely, as a test for tannic acid. Gelatin solutions are also unaffected by alum, lead acetate, ferric chloride, or the majority of metallic salts which precipitate proteids. Chondrin resembles gelatin in being precipitated from its solutions by tannic acid, but it also gives the reactions of mucin, being precipitated by acetic acid, lead acetate, and other reagents which do not affect gelatin.

**Notes.**—Like the true proteids, gelatin contains carbon, hydrogen, nitrogen, oxygen, and sulphur, but it is somewhat poorer in carbon and richer in oxygen than those bodies. It has little nutritive value in the proper sense of the term, *i.e.*, in replacing tissue waste, but when ingested it is assimilated and serves as a source of energy for the body. The appearance of solidity which small proportions of gelatin confer upon food preparations has invested it with a greatly over-estimated value as food material. It is not dissolved by cold water, but when immersed in that liquid it absorbs several times its weight, and is then readily reduced to the liquid form by the application of gentle heat.

## Gelsemii Radix.

**Gelsemium Root** is obtained from the yellow or Carolina jasmine, *Gelsemium nitidum*, Michaux (N.O. Loganiaceæ), a climbing plant indigenous to the southern United States, and growing in rich, moist soils along the sea coast from Virginia to the south of Florida. The drug is collected in the autumn; it usually consists of the dried rhizome of the plant with the larger roots attached, but sometimes smaller roots and portions of slender aerial stems are also present.



**Characters.**—Gelsemium rhizome usually occurs in nearly straight and cylindrical pieces, about 15 Cm. or more in length, and from 6 to 18 Mm. in thickness, brown or dark brownish-violet in colour, or marked with a network of purplish lines with yellowish-brown intervening spaces. The difference in colour is due to the outer cork cells being filled with a dark reddish-brown substance, whilst the inner ones contain a yellowish deposit; as growth proceeds, the outer dark layer of the rhizome becomes fissured, and the pale inner layer is thus partly disclosed. The roots are fibrous and somewhat smaller, on the average, than the rhizome; they are of a uniform yellowish-brown colour, finely wrinkled on the surface, and somewhat tortuous or sinuous in shape. The drug is hard and woody, breaking with an irregular splintery fracture, and the rhizome frequently exhibits silky fibres in the bast, similar to the more conspicuous ones found in the aerial stems. A transverse section of rhizome or root exhibits a distinctly radiate appearance, the thin cortex or bark enclosing a large, pale, yellowish-white wood, which consists of narrow bundles with small pores, alternating with straight, whitish, medullary rays. In the case of the rhizome, a small pith—frequently divided into four nearly equal parts—is also present, particularly in smaller and younger pieces; the silky fibres in the bast are isolated, or occur in groups of two or three, and form an interrupted ring, whereas in the aerial stem they are grouped in bundles. The bitter taste of the drug is due to the presence of alkaloids, which occur chiefly in the bark; the slight aromatic odour is probably due to the resin in the drug. Ash-yield about 2 per cent.

**Notes.**—The active principles of gelsemium are present only in small quantities, if at all, in the stem. The chief constituent of the drug is the intensely bitter and poisonous amorphous alkaloid gelseminine, which forms amorphous salts. A second alkaloid, gelsemine, is crystalline, probably non-toxic, and forms crystalline salts. Gelsemic or gelseminic acid is a crystalline substance found in gelsemium bark, which exhibits an intense bluish-green fluorescence in alkaline solutions; it appears to be identical with the  $\beta$ -methyl- $\alpha$ -esculetin (scopoletin or chrysotropic acid) found in belladonna root. Other constituents of the drug are about 6 per cent. of fixed oil and 4 per cent. of resin. It should be noted that the resinoid known as “gelsemin” is a mixture of substances obtained by evaporating an alcoholic extract of gelsemium to dryness.

## Gentianæ Radix.

**Gentian Root** is obtained from the yellow gentian, *Gentiana lutea*, Linné (N.O. Gentianæ), a perennial herb indigenous to Central Europe. The drug consists of the erect rhizome or root-stock and large fleshy roots of the plant, collected in the autumn and dried, the pieces being occasionally sliced longitudinally. It is collected in the mountainous districts of Germany, Switzerland, France, and Spain, that imported from France being preferred. When fresh the drug is whitish internally and almost odourless, but the colour darkens and a distinctive odour develops during the drying process, the fresh

root being sometimes made into heaps and allowed to heat and ferment in order to facilitate those changes.

**Characters and Tests.**—Gentian root usually occurs in nearly cylindrical yellowish-brown pieces about 15 to 20 Cm. long, and seldom exceeding 2.5 Cm. in thickness. Occasionally the pieces are longitudinally split, and they may also be obtained in thin transverse slices. The roots are much shrivelled and longitudinally wrinkled; the rhizome is often longer and thicker, without conspicuous longitudinal wrinkles, but marked by close transverse annulations, caused by leaf scars, and frequently terminated by a large bud protected by dry scaly leaves. Pieces of the drug are tough and flexible when slightly moist, but brittle when dried, the fractured surface being of a nearly uniform reddish-yellow colour. A transverse section shows a dark cambium ring separating the rather thick bark from the soft wood, the latter consisting almost entirely of parenchymatous tissue and exhibiting no radiate structure. Roots which have been longitudinally sliced before drying frequently exhibit transverse instead of longitudinal wrinkles, and are paler than usual internally. Gentian root contains no starch, and should not, therefore, yield any definite reactions with the tests for that body. The characteristic odour of gentian is probably due to some fermentation product formed during the operation of drying; it is more pronounced when the drug is moistened. The sweetness noted when gentian is first tasted is due to the sugar present; the bitter after-taste is due to the glucosides present. The drug should yield from 3 to 4 per cent. of ash.

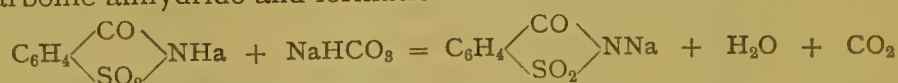
**Notes.**—The roots of other species of *Gentian*—*G. purpurea*, *G. pannonica*, *G. punctata*, etc.—are collected and dried in Switzerland and Austria; they are smaller, as a rule, than the roots of *G. lutea*, but all of them appear to possess similar properties. Fresh gentian root contains three bitter glucosidal principles—gentiopicroin, gentiin, and gentiamarin, but only the last two are found in the dried root, the gentiopicroin apparently becoming hydrolysed during the fermentative changes which take place on drying. A hexatriose sugar named gentianose, which is also found in the fresh root and disappears on drying, is first partially hydrolysed into gentiobiose and levulose, while further hydrolysis converts the gentiobiose into dextrose, and unduly prolonged exposure of the root to fermentative changes results in the conversion of all the sugars present into carbon dioxide and alcohol. Gentian root of good quality should yield 40 per cent. or more of extractive to cold water, but the yield of highly fermented root may be reduced to as little as 13 per cent. Gentiopicroin can be extracted from the fresh root in pale yellow crystals, which yield gentiogenin and dextrose when hydrolysed by emulsin or a dilute mineral acid. Gentiin is also crystalline, but gentiamarin is amorphous. Other constituents of gentian root are yellow, crystalline gentisic or gentianic acid, sucrose, pectin, and oily globules of what appears to be a cholesterol compound. Starch and tannin are absent.

## Glusidum.

**Gluside** or **Glucusimide**, commonly known as saccharin, is an imide having a sweet taste, obtained by a series of reactions from toluene. Its

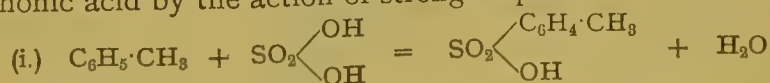
constitution is represented by the formula,  $\text{C}_6\text{H}_4\begin{smallmatrix} \text{CO} \\ \diagup \quad \diagdown \\ \text{SO}_2 \end{smallmatrix} \text{NH}$ . The preparation of gluside is described below.

**Characters and Tests.**—Gluside is a light, white, minutely crystalline powder, having an intensely sweet taste in dilute solutions. When heated it fuses, and then sublimes with partial decomposition. It is soluble in 400 parts of cold water, in 24 parts of boiling water, in 25 parts of 90 per cent. alcohol, and slightly in ether or chloroform, but as commercial saccharin is not absolutely pure, these figures are liable to some variation. It is very soluble in dilute solution of ammonia, and in solution of sodium bicarbonate with evolution of carbonic anhydride and formation of the soluble sodium salt.



100 parts of gluside when neutralised with sodium bicarbonate, yield about 113 parts of the sodium salt, which is known as "soluble saccharin." Neither saccharin nor soluble saccharin is charred when gently warmed with strong sulphuric acid, while sugar and many other organic substances, which may be present as impurities or adulterants, are blackened owing to the liberation of carbon by their decomposition. When evaporated with excess of solution of potassium hydroxide, and the residue maintained in a semi-fused condition for a few minutes, saccharin is decomposed, salicylic acid being the main product. In the fused mass it will be found as potassium salicylate, so that on dissolving this in water, neutralising the excess of potassium hydroxide with hydrochloric acid, and adding ferric chloride, the reaction for salicylates will be obtained, viz., a reddish-brown or purplish colour according to the concentration of the solution. A solution of 0.5 gramme of saccharin in 80 C.c. of warm water, set aside for twelve hours, deposits tabular crystals which melt between  $218.8^\circ$  and  $220^\circ$  C. The mother liquor, even when briskly shaken to facilitate crystallisation, should not deposit crystals of para-sulphamido-benzoic acid, which have a higher melting point.

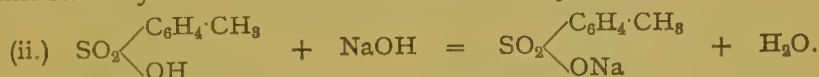
**Notes.**—The preparation and reactions of this compound provide material for illustrating a number of reactions having general interest in organic chemistry. It is made from toluene (methyl benzene). The first step is to prepare toluene sulphonic acid by the action of strong sulphuric acid on the toluene—



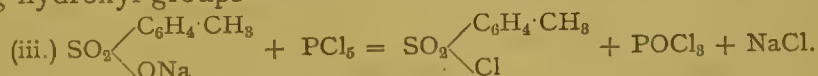
The facility with which the benzene hydrocarbons can be thus sulphonated distinguishes them from the paraffin hydrocarbons. Since toluene sulphonic acid is a di-derivative of benzene it can exist in the three varieties, distinguished by the three prefixes ortho-, meta-, and para-, according to the relative positions of the two substituting groups in the benzene nucleus. When, as in the formation of toluene sulphonic acid, a mono- is converted into a di-derivative, it has been found that the position taken up by the entering radical depends chiefly upon the nature of the substituting radical already present in the benzene nucleus, and only in a slight degree upon the nature of the second radical to be introduced. Thus, speaking generally, if the group already



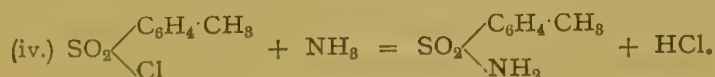
present be (HO), (CH<sub>3</sub>), or other hydrocarbon residue, Cl, Br, or (NH<sub>2</sub>), the second entering group takes up partly the ortho- and partly the para-position relatively to the first. On the other hand, when the mono-substitution product contains the following groups (NO<sub>2</sub>), (COOH), (SO<sub>2</sub>OH), (COH), then the meta-di-derivative is obtained. Those rules may be easily remembered by observing that the substances obtained by adding hydrogen to the groups of the first class are all difficult to oxidise, viz., H<sub>2</sub>O, CH<sub>4</sub>, HCl, HBr, and NH<sub>3</sub>; while, in a similar way, substances easily oxidised, viz., HNO<sub>2</sub>, H·COOH, H<sub>2</sub>SO<sub>3</sub>, H·COH, are obtained from the groups of the second class. By the action of sulphuric acid on toluene, therefore, it should be, and is, possible to obtain a mixture of ortho- and para-toluene sulphonic acids, but not any meta-toluene sulphonic acid. The relative proportions of the ortho- and para-acids obtained in this and analogous instances vary in each case, or in accordance with the conditions under which the reaction is carried out. It has been found that by sulphonating toluene at a temperature not exceeding 100° C., the ortho-acid is formed in greater quantity than the para-acid, and since the para-acid is useless (for reasons which will be explained later on) for the preparation of gluside, the reaction between toluene and sulphuric acid is carried out below 100° C. The mixture of ortho- and para-toluene sulphonic acids are then converted into their sodium salts by neutralisation with sodium hydroxide—



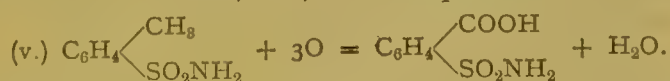
The sodium salts are next converted into the acid chlorides by the action of phosphorus pentachloride. This change essentially consists in the replacement of the hydroxyl of the acid by one atom of chlorine—behaviour which is quite typical of the reaction of phosphorus pentachloride (and trichloride) with bodies containing hydroxyl groups—



At this stage the para-compound mostly crystallises out, leaving a fluid residue containing chiefly ortho-toluene-sulphonic chloride. This compound by treatment with ammonia is converted into ortho-toluene-sulphonamide—

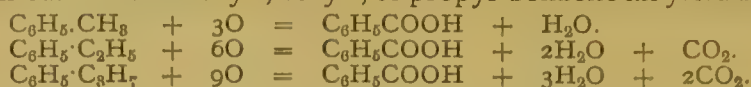


This reaction is quite typical of the behaviour of acid chlorides with ammonia. By oxidation with potassium permanganate in neutral solution the methyl group of the toluene residue in the sulphonamide is oxidised to carboxyl, giving, therefore, a derivative of benzoic acid, viz., ortho-sulphon-amido-benzoic acid—

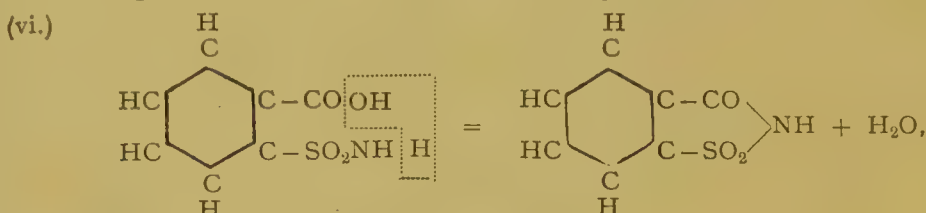


Oxidation of benzene derivatives containing alkyl side chains (methyl, ethyl, propyl, etc.) always finally results in the complete oxidation of these down to the last carbon atom connected with the benzene nucleus. Benzoic acid, or some derivative thereof, if the compound oxidised contained already some other substituting group or groups (as in the case under discussion), is conse-

quently obtained. Thus methyl-, ethyl-, or propyl-benzene all yield benzoic acid—

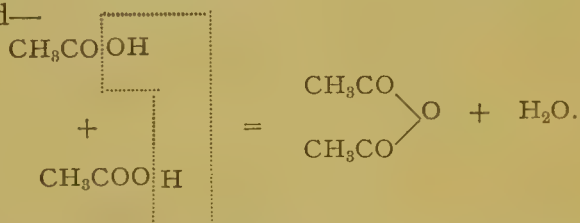


The ortho-sulphamido-benzoic acid immediately loses water—

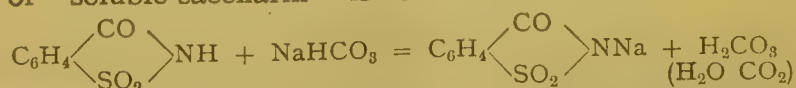


forming gluside, or benzoyl-sulphonic-imide.

The latter name is obtained by regarding gluside as a derivative of benzoyl,  $\text{C}_6\text{H}_5\text{CO}$  (the acid radical of benzoic acid  $\text{C}_6\text{H}_5\text{CO}\cdot\text{OH}$ ) containing the sulphon ( $-\text{SO}_2-$ ) and imido ( $=\text{NH}$ ) groups. It belongs to a class of bodies known as inner anhydrides, which are so-called because they are obtained by the separation of a molecule of water from one molecule of the acid. Compare equation (vi). Ordinary anhydrides are derived by the removal of water from two molecules of acid—

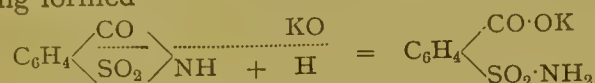


In describing the preparation of gluside, it has been mentioned that only the ortho-toluene-sulphonic acid was desired. The reason for this is that only the ortho-sulphamido-benzoic acid, containing the sulphamido and carboxyl groups linked to contiguous carbon atoms in the benzene nucleus, forms this inner (or intra-molecular) anhydride. The corresponding meta or para compounds in which the substituting sulphonamide and carboxyl groups are separated by one or two carbon atoms do not form inner anhydrides, and have, moreover, no sweet taste. With regard to this formation of inner anhydrides compare the behaviour of phthalic and succinic acids, and the formation of lactones from the  $\gamma$ -oxy-acids of the fatty series. The hydrogen atom combined with nitrogen in gluside can be easily replaced by electro-positive metals or groups. The acidic nature of this hydrogen is due to the influence of the closely associated electro-negative carbonyl (CO) and sulpho ( $\text{SO}_2$ ) groups. Typical organic acids which contain the carboxyl group  $\text{COOH}$ , owe their acid properties to the association of the hydroxyl with the carbonyl group. When aqueous solutions of gluside are treated with sodium bicarbonate the sodium compound or "soluble saccharin" is formed—

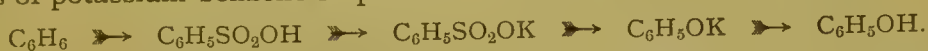


The reason why gluside is not readily charred by warm sulphuric acid can be easily seen by inspecting its formula. The side chains contain only one carbon atom and that is closely associated with oxygen, while the carbon in

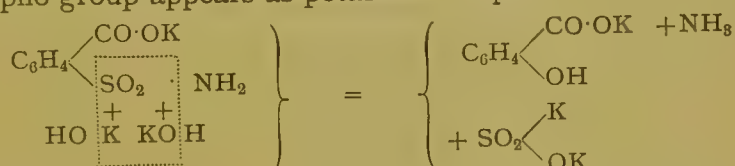
the aromatic nucleus is not easily disturbed by sulphuric acid, as is shown by the formation of such compounds as benzene sulphonic acid from benzene. When boiled with potassium hydroxide solution the anhydride formation is broken up, the potassium salt of the corresponding acid, ortho-sulphamido-benzoic acid, being formed—



When this solution is evaporated and fused with excess of potassium hydroxide, the sulpho-group is eliminated and replaced by hydroxyl, the potassium salt of ortho-hydroxy-benzoic acid (salicylic acid) being formed. The fused mass dissolved in water, and the excess of potassium hydroxide removed by neutralisation with hydrochloric acid, gives the characteristic test with ferric chloride for salicylates. The elimination of the sulpho-group by fusion with caustic alkali is quite typical of the benzene-sulphonic acids and their derivatives. Compare the process for the synthesis of phenol from benzene by means of potassium benzene sulphonate—



In the case of gluside, the nitrogen in the side chain is evolved as ammonia, while the sulpho group appears as potassium sulphite.



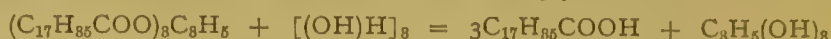
The sulphamido-benzoic acid referred to in the last official test is probably the para-variety derived from the corresponding para-toluene-sulphonic acid (*vide* process for preparing gluside). As a rule, inner anhydrides in the aromatic series can only be formed from bodies having the groups, from which the water is eliminated, in the adjacent or ortho-position. Consequently para-amido-benzoic acid will not eliminate water with formation of an imide, like the corresponding ortho-acid. This para-sulph-amido-benzoic acid is not sweet and hence its presence in saccharin diminishes the sweetening power according to the proportion present. For the absolutely pure benzoyl sulphonimide a sweetening power 500 or 600 times stronger than sugar is claimed.

## Glycerinum.

**Glycerin or Glycerol**, is a trihydric alcohol,  $\text{C}_3\text{H}_5(\text{OH})_3$ ; it is obtained by the action of alkalis or of superheated steam upon fats and fixed oils. The chief sources of glycerin are (1) the brine from which the soap has been salted out in soap factories; and (2) the aqueous liquor separated in candle factories from the fatty acids used in the manufacture of stearin candles. In the first case the oils and fats are saponified with caustic soda and the resulting soap precipitated from the solution by the addition of common salt, soap being insoluble in brine. In the second case the oils and fats are treated with steam under pressure and in some factories some lime or sulphuric

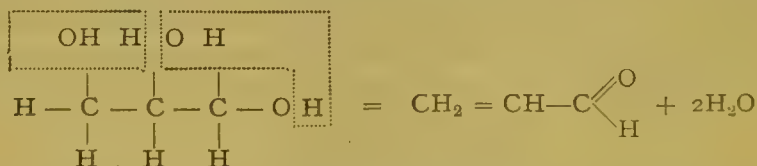


acid is added to facilitate the "saponification" of the fats. Although fats are almost unaffected by boiling water at ordinary pressure, that is at a temperature of  $100^{\circ}\text{C}$ ., they are rapidly saponified by superheated steam. Thus stearin, the chief constituent of solid animal fats when heated with water in a closed vessel under pressure is hydrolysed into fatty acid and glycerin—



and the fatty acid rises to the surface, forming an oily layer which may be separated from the solution of glycerin below. The details of the methods adopted for the recovery of the glycerin from this liquor and from the brine from the soap works vary in different factories and according to the nature of the accompanying substances. The liquor is neutralised and filtered, sometimes through charcoal, and concentrated by distillation under diminished pressure. The glycerin is then distilled by means of a current of superheated steam and the distillate received in a series of receivers. In the receiver next the still almost pure glycerin collects, and in the following one glycerin mixed with more or less water, and so on. Since the receiver next the still is maintained at a temperature which only allows the glycerin vapour to condense, the steam and some of the glycerin passes on to the remaining receivers, the temperature of the series diminishing from the first one onwards. The diluted glycerin which collects in the second and subsequent receivers is concentrated by evaporation under diminished pressure so as to remove the water without subjecting the glycerin to a risk of decomposition through overheating. A crude glycerin, used for some technical purposes, is prepared by simple filtration and concentration; for medicinal purposes and for the manufacture of nitro-glycerin it can only be obtained sufficiently pure by distillation.

**Characters and Tests.**—Glycerin is a clear, colourless, syrupy liquid, of a sweet taste; inodorous, miscible with water and 90 per cent. alcohol; neutral to litmus; insoluble in ether, chloroform and fixed oils. It absorbs moisture when exposed to the air. When decomposed by heat it evolves intensely irritating vapours, which owe this property chiefly to acrylic aldehyde. This is produced from the glycerin by the elimination of the elements of water—



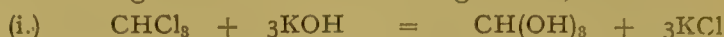
Specific gravity, 1.260, which corresponds to about 98 per cent. glycerin and 2 per cent. water; absolute glycerin has a specific gravity of 1.265 at  $15^{\circ}\text{C}$ . Glycerin should be free from lead, copper, arsenium, iron, calcium, potassium, sodium, ammonium, chlorides and sulphates. Absence of glucose or other reducing sugar may be proved by boiling it with solution of potassio-cupric tartrate (Fehling's solution), when no red precipitate of cuprous oxide should appear. The same test may be applied for cane sugar, only in this case it is necessary to first boil the glycerin for a few minutes with a few drops of dilute hydrochloric or sulphuric acid, in order to hydrolyse or "invert" the cane

sugar, which does not itself reduce Fehling's solution. After "inversion," the liquid should be rendered faintly alkaline with potash or soda, and then boiled with Fehling's solution. It should undergo no darkening in colour at ordinary temperatures when mixed with an equal volume of solution of ammonia and a few drops of solution of silver nitrate. Any darkening with ammonia and silver nitrate would indicate substances of an aldehydic nature (*e.g.*, formic and acrylic aldehydes), which consequently reduce silver nitrate in neutral or alkaline solution (compare the behaviour of aldehydes). Such bodies might be produced by overheating during the distillation in the process of manufacture. The addition of ammonia may be regarded as a precautionary measure to neutralise any acid present, since the black precipitate of silver cannot be obtained in strongly acid solutions. If agitation with sulphuric acid develop a dark coloration, foreign organic matter is indicated—sometimes, but not often, cane sugar or glucose. Glycerin is not charred by cold strong sulphuric acid, but forms an ester, glyceryl sulphuric acid, by virtue of its alcoholic nature—



When heated with an equal volume of 90 per cent. alcohol and diluted sulphuric acid no fruity odour of ethyl butyrate should be produced. The odour of this substance would indicate the presence of butyric acid in the glycerin, the butyric acid being derived from butyrin (the glyceryl ester) which is a constituent of many fats. Since butyric acid is one of the lower fatty acids it is more easily volatile and more soluble in water than the higher fatty acids like stearic; hence its separation from glycerin when present in the sweet liquors of the candle and soap factories requires some care. The formation of its ethyl ester having the fruity odour is analogous to that of ethyl acetate (*vide* Æther Aceticus). Absence of more than minute traces of arsenium, derived from the saponifying agents used in manufacture, is shown in the following way: dilute 2 C.c. of the glycerin with 5 C.c. of a mixture of hydrochloric acid and water (1 to 7) in a test tube, add 1 gramme of pure zinc and cover the mouth of the test tube with a cap of filter paper which has been moistened with a few drops of solution of mercuric chloride and afterwards dried. Under these conditions the paper cap should show no yellow stain after the action has continued fifteen minutes showing that the hydrogen evolved is free from arseniuretted hydrogen which would be formed by the action of the nascent hydrogen on any arsenic compounds present. The yellow stain appears to be due to the production of a substance having the formula  $\text{AsH}(\text{HgCl})_2$ . In performing this test particular care must be taken to ensure that the reagents and apparatus are themselves free from arsenic; the best plan is always to make a blank experiment first, *i.e.*, without the glycerin. In order to prevent any of the reaction mixture being projected mechanically by the effervescence upon the paper cap, the test tube employed should be a long one and a plug of cotton-wool may be inserted in the upper part. When heated in an open capsule glycerin evolves acrid vapours and is finally dissipated leaving no ash, which shows that it has been purified by distillation from mineral matters which accompany it in the crude state.

**Notes.**—Glycerin is the simplest triatomic alcohol, for compounds containing more than one hydroxyl (HO) group attached to each carbon atom are unknown. Refer to the notes on Chloral Hydras. Attempts to prepare, *e.g.*, such bodies as  $\text{CH}_2(\text{OH})_2$  or  $\text{CH}(\text{OH})_3$ , result in the separation of water and a re-arrangement of the remaining atoms, thus:



$\text{CH}(\text{OH})_3$  is orthoformic acid; it is unknown in the free state since it decomposes at once into ordinary formic acid and water—



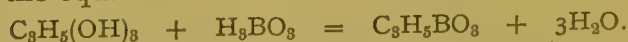
Glycerin is very useful in pharmacy on account of its solvent action, particularly in relation to some substances like borax, which are not very freely soluble in water. Solutions of these (and other substances) in glycerin constitute the official “glycerins” which are used often undiluted for local application as a “paint,” the viscid consistence of the glycerin facilitating their employment in this manner. On account of its high boiling point, glycerin is hardly volatile at ordinary temperatures, and, being hygroscopic, it even absorbs moisture from the air, hence the addition of glycerin to pills, confections, etc., from becoming dry and hard. [*Dose.*—1 to 2 fluid drachms.]

## Glycerina.

**Glycerins.**—Solutions of various drugs in glycerin constitute the class of preparations known as “glycerins” or “glyceroles.” Glycerin may be used on account of its special solvent action in certain substances, or because its medicinal action is desired in association with that of the dissolved medicament, or because the viscosity of the glycerin solution enables it to be employed in the form of paint. There are nine official “glycerins.”

### **Glycerinum Acidi Borici.** GLYCERIN OF BORIC ACID.

Boric acid, in powder, is stirred into glycerin heated to  $150^\circ \text{C.}$ , and the heating continued until the whole has dissolved and a loss in weight has occurred corresponding closely with the loss of water necessary for the formation of the boric acid ester of glycerin, or glyceryl borate, according to the equation—



Some more glycerin is then stirred in. It is chiefly used as a lotion dissolved in water, the glyceryl borate being more or less dissociated in aqueous solution.

### **Glycerinum Acidi Carbolici.** GLYCERIN OF PHENOL.

Contains 1 part of phenol with sufficient glycerin to make 5 fluid parts.

### **Glycerinum Acidi Tannici.** GLYCERIN OF TANNIC ACID.

Contains 1 part of tannic acid with sufficient glycerin to make 5 fluid parts.

### **Glycerinum Aluminis.** GLYCERIN OF ALUM.

A solution of alum in glycerin and water.



**Glycerinum Amyli.** GLYCERIN OF STARCH.

A mixture of starch, glycerin, and water; heated together to form a translucent jelly.

**Glycerinum Boracis.** GLYCERIN OF BORAX.

Contains 1 part of borax and 6 fluid parts of glycerin. Part of the borax is decomposed into boric acid and a more basic borate.

**Glycerinum Pepsini.** GLYCERIN OF PEPSIN.

Contains 5 grains of pepsin dissolved in each fluid drachm of glycerin and water, acidulated with hydrochloric acid. [*Dose*.—1 to 2 fluid drachms.

**Glycerinum Plumbi Subacetatis.** GLYCERIN OF LEAD SUBACETATE.

Lead acetate and oxide are boiled with water and glycerin to form a solution of the subacetate. The product is filtered and evaporated to remove most of the water. The water is necessary, in the first place, to facilitate the reaction between the two lead salts.

**Glycerinum Tragacanthæ.** GLYCERIN OF TRAGACANTH.

A mixture of tragacanth in powder, water, and glycerin; triturated to form a homogeneous paste.

## Glycyrrhizæ Radix.

**Liquorice Root** is obtained from *Glycyrrhiza glabra*, Linné. (N. O. Leguminosæ) and other species, but chiefly the former, the peeled root and peeled subterranean stem being official. The plants yielding the drug are widely distributed over Southern Europe and eastward to Central Asia, being largely cultivated for the preparation of extract; *G. glabra* is also cultivated to a limited extent in England, near Mitcham and in Yorkshire, but the dried official root is chiefly imported from Spain and the South of France. There are several other varieties in commerce, such as Russian, Persian, etc., but they do not agree with the official description. The plants produce tall, erect, herbaceous stems and stout perennial roots which divide, a few inches below the surface of the ground, into several long straight descending branches, beset with slender wiry rootlets. Long horizontal subterranean stems (runners or stolons) are also given off by the principal roots near the surface, those being provided with buds which develop into aerial stems if the runners be allowed to remain undisturbed until the following year. The whole of the underground part of the plant is collected in the autumn, carefully dried, and peeled if intended for medicinal purposes.

**Characters.**—Liquorice root is imported from Spain and the South of France in bundles of long, nearly cylindrical, dark, reddish-brown pieces, which are usually longitudinally wrinkled and not scaly, but bear on the surface small transverse root-scars, and, in the case of runners, minute dark buds. When peeled the pieces are shorter, yellowish in colour, and have a smooth fibrous surface. The pieces break with a coarse fibrous fracture, and a transverse section exhibits a yellow wood—consisting of narrow, porous wedges of vascular tissue, alternating with numerous medullary rays—encircled by a thick cortex with groups of bast fibres arranged in radial lines, the groups appearing as rows of dark points opposite to the wedges of vascular tissue. In addition, the pieces

of subterranean stem, which constitute the greater portion of the drug, are distinguished by the presence of a small dark pith. The characteristic sweet taste of liquorice is due to the presence of glycyrrhizin and sugar; the faint but peculiar earthy odour also appears to be due to glycyrrhizin. Ash-yield, 3 to 4 per cent.

**Notes.**—The distinctive characters of Spanish liquorice root, which is the only imported variety that appears to satisfy official requirements, are its sweet taste free from bitterness, the yellow colour of a transverse section, the fibrous bark, and the presence of minute buds and pith in most of the pieces. Russian liquorice, the product of *G. glandulifera*, is usually imported in the peeled condition, and differs from Spanish in being slightly bitter; it is also larger as a rule, and consists chiefly of purplish roots with scaly cork, the pieces being destitute of pith and exhibiting no traces of buds. Other varieties of liquorice root, derived from *G. echinata*, have a bitter taste similar to that of the Russian root, and are equally unsuitable for medicinal purposes. The chief constituent of liquorice is about 7 per cent. or more of glycyrrhizin, a sweet principle, which consists of the potassium and calcium salts of glycyrrhizinic acid. It can be obtained as a white, crystalline powder, which is slightly soluble in water, and combines readily with alkalies to form soluble compounds. Glycyrrhizinic acid can be obtained as a colourless, crystalline substance, which yields glycyrrhetic and glycuronic acids on hydrolysis, but no sugar. Liquorice root contains about 3 per cent. of the acid, which is soluble in boiling acetic acid, but only very slightly soluble in ether, alcohol, or water. It has a sweetish taste and acid reaction, combining with alkalies to form crystallisable soluble salts which are intensely sweet. A substance resembling it has been obtained from the rhizome of *Polypodium vulgare*, the leaves of *Myrrhis odorata*, and the bark of *Lucuma glycyphlœa*. Other substances which have been found in liquorice root are sugar, asparagin, starch, proteids, fat, resin, and various salts, whilst a small quantity of tannin is said to occur in the outer bark of the root. An amorphous bitter substance named glycyramarin has also been obtained from the root of *G. glandulifera* or *G. echinata*.

## Gossypium.

**Cotton or Cotton Wool** consists of the hairs of the seed of *Gossypium barbadense*, Linné (N.O. Malvaceæ), and of other species of *Gossypium*. The plants are herbs, shrubs, or small trees cultivated in tropical and sub-tropical countries, and producing three to five-celled capsular fruits containing numerous seeds covered with a wool-like mass of long white or yellowish hairs. Those are removed from the seeds, separated from impurities by means of special machinery, and freed from adhering fatty matter, so as to render them more absorbent. That is effected by boiling the crude "wool," under pressure, with a dilute caustic alkali, after which it is washed, bleached by the action of chlorinated lime and hydrochloric acid, again washed, dried, and the fibres mechanically loosened and separated, so as to make a fleecy, wool-like mass.

**Characters and Tests.**—Cotton wool occurs, when purified, in long, white, soft filaments, about 2 to 4 or 5 Cm. long, and 0.02 Mm. broad, each consisting of an elongated cell which appears, when magnified, as a flattened twisted band, with slightly thickened, rounded edges. It is inodorous, tasteless, and should absorb water readily, the absence of fatty matter being thus indicated. Cotton should impart to water in which it is immersed neither an alkaline nor an acid reaction, thus showing that it has been thoroughly washed after being freed from fatty matter and bleached. On incineration in air it burns, leaving less than 1 per cent. of ash. An ammoniacal solution of cupric oxide (*not* of copper ammonio-sulphate, as officially stated) should dissolve cotton almost completely, the dissolved cellulose being thrown out of solution again on adding an acid.

**Notes.**—Purified cotton consists chiefly of cellulose, associated with traces of inorganic matter, albuminoids, etc. The fatty matter which forms a thin coating on crude cotton consists of a wax which is soluble in alcohol and ether, mixed with stearic and palmitic acids. Cotton is insoluble in hot solution (8 per cent.) of potassium hydroxide, is not permanently stained yellow by picric acid solution, and contains only traces of nitrogenous substances, being thus distinguished from animal fibres. Iodine solution colours it yellow, the colour changing to blue on treatment with sulphuric acid, this cellulose reaction distinguishing cotton from many other vegetable fibres.

## Granati Cortex.

**Pomegranate Bark** is obtained from *Punica Granatum*, Linné (N.O. Lythrarieæ), a shrub or small tree indigenous to North-Western India, but cultivated in countries bordering on the Mediterranean and in sub-tropical regions generally. The dried bark of both stem and root is official.

**Characters.**—Pomegranate bark seldom occurs in quills, but usually in irregular curved or channelled pieces, varying from 5 to 10 Cm. in length, and from 12 to 25 Mm. in width. The root bark has a rough, yellowish-grey outer surface, marked with irregular conchoidal depressions due to exfoliation of the outer portion of the bark; the inner surface is smooth and yellow, with irregular brownish blotches. The bark breaks with a short fracture and the fractured surface is nearly white; a transverse section exhibits fine tangential and still finer radial lines when examined with a lens. The stem bark is in straighter channelled pieces than the root bark and may also occur in quills. It frequently bears the minute apothecia of lichens, is smoother than the root bark and exhibits no conchoidal depressions, though it presents occasional shallow longitudinal furrows and bands of pale cork. Neither root nor stem bark has any distinctive odour, but both possess an astringent, slightly bitter taste, due to the presence of tannin and alkaloids respectively. Ash-yield, 5 to 13 per cent.

**Notes.**—The root bark is distinguished by its rough surface with conchoidal depressions, and the stem bark by its comparatively smooth outer surface bearing lichens. The bark of *Buxus sempervirens*, which has been found mixed with pomegranate bark, is bitter, but not astringent, as it contains no tannin. The chief constituents of the drug are three liquid alkaloids—pelletierine



(punicine), isopelletierine (isopunicine), and methylpelletierine (methyl-punicine)—and the crystalline alkaloid pseudo-pelletierine (pseudo-punicine or grantonine). The pelletierine of commerce appears to consist of pelletierine, properly so-called, and isopelletierine, the two constituents of the bark to which its anthelmintic power is due; the other two bases are inactive. The root bark may contain 0·6 to 0·7 per cent. of alkaloids, but the stem bark does not often contain more than 0·5 per cent. The proportion diminishes when the bark is kept, and the average in commercial bark, which is chiefly obtained from the stem, is said to be only about 0·35 per cent. The drug also contains about 22 per cent. of tannin (punico-tannic acid), which is said to be identical with gallotannic acid.

## Guaiaci Lignum.

**Guaiacum Wood**, also known as “*lignum vitæ*,” is obtained from the stem of *Guaiacum officinale*, Linné (N.O. Zygophyllæ), a native of Hayti, Jamaica, and other parts of the West Indies, and *G. sanctum*, Linné, a tree found in Cuba, the Bahamas, etc. The trunks of the trees consist chiefly of a dark heartwood, in which brown zones alternate with darker olive-green or nearly black ones; it is surrounded by a narrow ring of yellowish sapwood and a grey or ash-coloured bark. The wood of *G. sanctum* occurs in smaller pieces than that of *G. officinale*, and is also paler and less dense. After the trees are felled, the bark is removed and the heartwood cut into logs or billets for export, being used for medicinal purposes in the forms of chips, turnings, or raspings.

**Characters and Tests.**—Guaiacum wood is dark greenish-brown in colour, dense, hard, and so heavy that it sinks in water. Any lighter, pale yellow chips or turnings consist of the sapwood, and should be rejected. The taste of the heartwood when chewed is acrid, owing to the presence of resin, which also causes it to give off a somewhat aromatic odour, recalling that of benzoin, when heated. The resin assumes a deep blue colour when treated with oxidising agents, so that an alcoholic tincture of the heartwood assumes a blue colour on the addition of a dilute solution of ferric chloride.

**Notes.**—When examined with a lens the medullary rays of guaiacum wood are seen to be straight, narrow, and closely approximated; the vessels are distinct, usually single, and arranged in concentric zones. The chief constituent of the wood is the resin, which is present to the extent of 20 to 25 per cent. in the heartwood, though only about 3 per cent.—and that of different composition—occurs in the sapwood. The drug yields about 3 to 4 per cent. of extractive soluble in water, and about 1·5 per cent. of ash.

## Guaiaci Resina.

**Guaiacum Resin** is obtained from the stem of *Guaiacum officinale*, Linné (N.O. Zygophyllæ), or *G. sanctum*, Linné. It exudes in tears spontaneously or after deep cuts have been made in the stem or branches, but is chiefly extracted by the aid of heat. A billet about three feet long is bored longitudinally

with an auger, and one end of it placed on a fire, the heat of which causes the resin to flow out of the boring at the other end; or, the wood is reduced to chips or sawdust and boiled in a solution of common salt, the resin being skimmed off as it rises to the surface. The resin which occurs in tears is the best, containing less insoluble matter than the masses; that extracted by boiling the wood is most inferior in quality.

**Characters and Tests.**—Guaiacum resin may occur in rounded tears about 25 Mm. in diameter, but is usually seen in large dark-coloured masses, often more or less covered with a greenish powder. It is brittle, breaking with a clean, glassy fracture, and thin splinters are transparent, their colour varying from yellowish-green to reddish-brown. The latter is the natural colour of the resin prior to oxidation taking place. The powdered resin is greyish, but becomes green on exposure to light and air, as the result of oxidation. The taste of the resin is slightly acrid, and its odour when warmed is somewhat balsamic, recalling that of benzoin. The resin is easily identified by its behaviour with oxidising agents, a solution in 90 per cent. alcohol assuming a deep blue colour on the addition of a dilute solution of ferric chloride. The colour is destroyed by reducing agents, but restored by oxidising agents.

**Notes.**—Tears of guaiacum resin leave about 1.5 per cent. of residue—gum, vegetable débris, etc.—when dissolved in strong alcohol; the masses may leave from 7.5 to 25 per cent. The chief constituents of guaiacum resin are guaiaconic, guaiaretic, and guaiacic acids; the resin also contains guaiac- $\beta$ -resin, guaiac-yellow, vanillin, saponin, etc. The guaiaconic acids are colourless and constitute about 70 per cent. of the resin;  $\beta$ -guaiaconic acid is crystalline, but  $\alpha$ -guaiaconic acid is amorphous and yields guaiac-blue when treated with oxidising agents. Guaiaretic acid, of which the resin may contain more than 10 per cent., is a light-brown, amorphous substance. Guaiac- $\beta$ -resin is a brown amorphous decomposition product of the guaiaconic acids, and yields guaiac-blue when oxidised. On dry distillation guaiacum resin yields guaiacene, guaiacol (pyrocatechin methyl ether), creosol, and pyro-guaiacin. Guaiacene is said to be the aldehyde of tiglic acid,  $C_5H_8O_2$ , an acid of the oleic series, isomeric with angelic acid, and also found in croton oil.

[Dose.—5 to 15 grains.

## Hæmatoxyli Lignum.

**Logwood** is the heartwood of *Hæmatoxylon campechianum*, Linné (N.O. Leguminosæ), a tree of medium size, indigenous to Campeachy, Honduras, and other parts of Central America, but naturalised in Jamaica and other West Indian islands. The wood is exported in logs or billets, from which the bark and sapwood have been removed. It is usually seen in chips or coarse powder, which has mostly been prepared as a dye-stuff by being exposed in large moist heaps and fermented. When required for medicinal use, however, care should be taken to secure logwood which has not been fermented; it has then a sweeter taste and is more astringent.

**Characters.**—Logwood is hard, compact, and heavy, dull orange to purplish-red externally, and reddish-brown internally, the colour varying with

the proportion of colouring matter present. A transverse section exhibits narrow and closely approximated medullary rays, also narrow concentric dark zones alternating with paler ones in which the presence of colouring matter is less evident. The chips or coarse powder should be unfermented, the taste then being sweet and astringent, owing to the presence of hæmatoxylin and tannin respectively; the slight and somewhat agreeable odour, recalling that of violets, is probably due to the presence of a trace of volatile oil. When chewed the wood colours the saliva dark pink or violet, a similar colour being imparted by logwood to dilute aqueous solutions of caustic alkalies.

**Notes.**—Unfermented logwood contains about 10 per cent. of a colourless crystalline body named hæmatoxylin,  $C_{16}H_{14}O_6 \cdot 3H_2O$ , together with tannin, resin, quercetin, and a trace of volatile oil. Hæmatoxylin yields pyrogallol when fused with alkalies. It has a sweet taste, resembling that of liquorice, without bitterness or astringency, and the colourless crystals in which it occurs when pure tend to acquire a yellowish or yellowish-rose colour on keeping, also becoming bitter, acrid, and slightly astringent as oxidation proceeds. This change appears to be due to the gradual formation of hæmatein,  $C_{16}H_{12}O_6$ , a substance which can be obtained in dark reddish-brown or violet plates and scales, with a fine green lustre. A similar change takes place when logwood is fermented, the wood becoming darker in colour, while dark green lustrous patches of hæmatein form on the surface; or the change may be brought about more rapidly by the action of alkalies upon hæmatoxylin, the resulting hæmatein then forming blue, red, or purple solutions with the alkalies present. Hæmatein can be reconverted into hæmatoxylin by the action of hydrogen or sulphurous acid.

## Hamamelidis Cortex.

**Hamamelis** or **Witch Hazel Bark** is obtained from *Hamamelis virginiana*, Linné (N.O. Hamamelideæ), a shrub indigenous to the United States and Canada, the bark being collected in the spring and dried.

**Characters.**—Hamamelis bark occurs usually in thin channelled or curved pieces about 1.5 Mm. thick and varying from 0.5 to 2 Dcm. long. They are sometimes covered with a smooth silvery grey or ash-grey cork marked with transverse lenticels; in older pieces the cork is darker in colour, fissured and scaly. Frequently, however, the pieces of bark are free from cork, the smooth reddish-brown cortex being then exposed and exhibiting under the lens slight transverse striations. The inner surface of the bark is pale reddish-pink in colour and finely striated longitudinally, small portions of dense white wood with numerous fine medullary rays being frequently found adhering to it. The cork and cortex break with a short fracture, but that of the inner portion of the bark is coarsely fibrous, the bast tending to separate into laminæ, owing to the presence of numerous tangentially elongated groups of bast fibres. A smoothed transverse section of the bark exhibits those groups of bast fibres and a dark narrow cortex, the latter separated from the bast by a pale tangential line of sclerenchymatous cells; in some pieces of bark those sclerenchymatous cells may form the outer layer, owing to the removal of much of the cortex, in



addition to the cork. The bark has no marked odour; its astringent taste is due to the presence of tannin.

**Notes.**—The distinctive characters of hamamelis bark are its pinkish colour, pale grey but not glossy cork, and the line or ring of sclerenchymatous cells. Oak bark differs from it by having a silvery, glossy bark, and being usually of a brownish colour; willow bark has a dull greenish-brown cork, is usually striated on the outer surface, and does not exhibit a line of sclerenchymatous cells. The most important constituent of hamamelis bark is tannin, of which it contains about 6 per cent.; gallic acid, resin, fat, phytosterin, glucosides, traces of bitter and pungent principles, volatile oil, and small quantities of triglycerides are also present. The tannin is partly crystalline (hamamelitannic acid) and partly amorphous. Phytosterin (m.p., 133° C.) is a neutral principle which is closely allied to cholesterin. The preparation known as "hamamelin" is a mixture of substances obtained by extracting the bark or leaves of *H. virginiana* with alcohol and evaporating the resulting solution to dryness; the dark-brown extract obtained from the bark is usually richer in tannin than the light-brown extract obtained from the leaves, but the leaf extract, which is sometimes coloured green with powdered hamamelis leaves, is yielded in larger proportion.

## Hamamelidis Folia.

**Hamamelis or Witch Hazel Leaves** are obtained from *Hamamelis virginiana*, Linné (N.O. Hamamelideæ), both fresh and dried leaves being employed. They are usually collected in the autumn and, when dried, occur in commerce in a somewhat indifferent state of preservation, being frequently discoloured, broken, and pressed together into more or less compact masses.

**Characters.**—Hamamelis leaves are from 7 to 15 Cm. in length, dark green or brownish-green on the upper surface, and paler on the under surface. They are broadly oval in outline, obtuse at the apex, and have a sinuate margin. Towards the base, the lamina becomes narrowed and oblique; it is also slightly heart-shaped and shortly stalked. The leaves are pinnately veined, the veins being more prominent on the under surface. The lateral veins, which run direct from the midrib to the margin, are practically the only ones that can be seen on the upper surface. In the angles formed by the lateral veins branching or stellate hairs may usually be found, being more frequent on young leaves. The slight odour of the leaves is not characteristic; their astringency is due to tannin, and the presence of some bitter principle is also indicated by the taste.

**Notes.**—The distinctive characters of hamamelis leaves are the sinuate margin, the lateral veins running direct to the margin, and the branching or stellate hairs. Very young leaves are brown in colour and densely hairy. The drug contains tannin, gallic acid, a bitter principle, and a trace of volatile oil. On distilling either fresh or dried leaves with water or dilute alcohol, some decomposition appears to take place, as the distillate possesses an odour differing from that of the leaves, owing, apparently, to the formation of some aromatic body. The official liquid extract also contains a trace of protocathechuic acid.

The dry extract of the leaves, known as "hamamelin," is made with strong alcohol, and is said to contain most tannin if made from autumnal leaves.

## Hemidesmi Radix.

**Hemidesmus Root**, also known as Indian Sarsaparilla, is obtained from *Hemidesmus indicus*, R. Brown (N.O. Asclepiadeæ), a climbing plant, indigenous to India and Ceylon. The dried root has long been employed in India as a substitute for sarsaparilla.

**Characters.**—Hemidesmus root occurs in long, rigid, nearly cylindrical pieces, which are tortuous, longitudinally furrowed, and transversely fissured at intervals. They are hard and woody, often more than 30 Cm. long, but seldom exceed 6 Mm. in thickness. In colour they vary from reddish-brown to dark-brown or nearly black. The pieces branch occasionally, bear a few fibrous rootlets, and may have portions of the slender aerial stems—marked with opposite leaf scars—attached to one extremity. At one side of the root the thin cork is frequently separated from, and raised above, the cortex. A transverse section exhibits a thin greyish bark or cortex containing numerous laticiferous cells, surrounding a larger, porous yellowish wood, which is not distinctly radiate. The root has a somewhat sweet taste and a fragrant odour—recalling that of tonka beans—which is due to the presence of coumarin.

**Notes.**—The distinctive characters of hemidesmus root are its rigid and tortuous-character, the transverse cracks, easily separable cork, and large yellowish wood. Sarsaparilla differs in being free from transverse cracks, while it has a firmly adherent cork and a small wood. Starch occurs in considerable quantity in the parenchymatous tissue of hemidesmus root, and tannin is found in the cork, but coumarin ("smilasperic" or "hemidesmic" acid), is the only important constituent of the root that is known.

## Hirudo.

**Leeches** are fresh-water annelids, those used for medicinal purposes being of two kinds—the speckled leech, *Sanguisuga medicinalis*, Savigny (Order Gnathobdellida), and the green leech, *S. officinalis*, Savigny. Both kinds are imported from various parts of Europe, the speckled (Swedish or German) leech being found in Central and Northern Europe, while the habitat of the green (Hungarian) leech is Southern Europe. They occur in fresh-water ponds, swimming with an undulating motion, or crawling by the aid of their suckers, attaching themselves first by one extremity and then by the other, and alternately stretching out and contracting their bodies. They are used to extract blood from congested parts of the body.

**Characters.**—Leeches have a soft, smooth body, 5 Cm. or more in length, tapering to each extremity. A section of the body appears plano-convex, the convexity being on the dorsal surface, which is olive-green in colour, with six rusty-red longitudinal stripes. The body is also divided into twenty-six segments, each of which, except those at the extremities, is marked by five fine

rings, the total number of those annulations being one hundred and two. The anterior end of the body is terminated by a small sucker surrounding the tri-radiate jaws, and the posterior end is similarly terminated by a large adhesive sucker, consisting of seven segments fused together. In *S. medicinalis* the ventral surface is greenish-yellow, with black spots; in *S. officinalis* the ventral surface is olive-green, without spots.

**Notes.**—The distinctive characters of leeches are the possession of two suckers, the presence of five rings on each segment except those at the extremities, and the absence of bristles and “foot-tubercles” such as are found in the higher Annelida. Inside the anterior sucker, by means of which the leech attaches itself, are three curved chitinoid plates, placed radially, and having finely serrated edges. The leeches bite through the skin with these jaws or “teeth,” and continue to draw blood until they are gorged, when they drop off. The buccal secretion of the leeches contains hirudin, a substance which retards coagulation, and the blood takes several months to digest, but the gorged leeches can be made to disgorge it by placing them in a 16 per cent. aqueous solution of common salt, then taking them by the tail, one by one, dipping them into warm water, and passing them lightly between the fingers. After being replaced in fresh water they should be fit for reapplication at the end of eight or ten days.

## Homatropinæ Hydrobromidum.

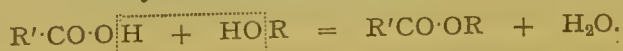
**Homatropine Hydrobromide**,  $C_{16}H_{21}NO_3$ , HBr, is the salt of an alkaloid prepared artificially from atropine. If atropine be heated with alkalis it undergoes hydrolysis, a base called tropine and an organic acid, tropic acid, being the products. The tropic acid combines with the alkali, and the tropine may be removed by “shaking out” the hydrolysed product with ether. If the tropine be then heated with certain organic acids (in presence of hydrochloric acid) the acid and base combine with formation of an ester, water being eliminated. The group of mydriatic alkaloids having the constitution of esters derived from tropine, or some allied base, and tropic acid or allied acid, are called tropëines. To obtain homatropine the tropine, obtained as described above, is recombined with mandelic acid. Homatropine belongs, therefore, to the group of artificial tropëines, and may be called tropine mandelate, just as atropine may be regarded as tropine tropate.

**Characters and Tests.**—Homatropine hydrobromide is a white crystalline powder or aggregation of minute trimetric crystals, soluble in 6 parts of cold water and 133 parts absolute alcohol. The solutions should be neutral to litmus. A dilute aqueous solution, when applied to the eye, powerfully dilates the pupil. Heated on platinum foil it fuses and burns without leaving an appreciable residue. If 0.2 C.c. of chloroform be shaken with 1 C.c. of a 10 per cent. aqueous solution, to which solution of chlorine has been cautiously added, avoiding excess, the globule of chloroform which separates will have a brown colour, due to bromine which has been displaced by the chlorine and extracted by the chloroform from the aqueous layer. A 2 per cent. aqueous solution yields no precipitate on the cautious addition of solution of ammonia previously diluted with twice its bulk of water (soluble salts of atropine give a distinct



precipitate of atropine under these conditions), but dilute solution of potassium hydroxide, added drop by drop, gives a white precipitate of homatropine, which is, however, soluble in excess of the reagent. With aqueous solutions of the salt, solution of iodine gives a brown precipitate of homatropine tri-iodide (*i.e.*, a hydriodide with two atoms of iodine), and with mercuric chloride a precipitate consisting of a double salt of the alkaloid and mercury; but the formation of insoluble compounds with iodine or mercuric chloride is not peculiar to homatropine, since it may be observed with nearly all alkaloids—hence those substances are general alkaloidal reagents. If about 0.01 gramme of the substance be dissolved in a little water, the solution rendered alkaline with ammonia (to liberate the alkaloid) and shaken with chloroform, the separated chloroform will leave, on evaporation, a residue of homatropine which it has extracted from the solution. The evaporation is best conducted in a dish or watch-glass on a water-bath, so as to avoid decomposition by overheating. If now to this residue 1.5 C.c. of a 2 per cent. alcoholic solution of mercuric chloride be added, and the dish again warmed, a yellow precipitate of mercuric oxide, turning red, appears. This reaction is due to the strongly basic nature of the alkaloid, which enables it to behave like an alkali towards mercuric chloride; it is also yielded by atropine and hyoscyamine, but not by the salts of any of the alkaloids, hence the necessity for the preliminary separation of the alkaloid from the hydrobromide by means of ammonia and chloroform. When treated with fuming nitric acid, and subsequently with an alcoholic solution of potassium hydroxide, as described under “Atropina,” no reddish-violet colour is produced as by atropine, but the product is reddish-yellow. The salt affords the reactions characteristic of hydrobromides.

**Notes.**—The tropëines are esters because they are derived from an acid and an alcohol just like ethyl acetate, according to the general equation—



The esters derived from alcohols like ethyl alcohol, containing a hydrocarbon radical, are neutral bodies. The tropëines, however, although esters, are strongly basic alkaloids, for tropine has the constitution of methyl-oxyethyl-tetrahydropyrine—

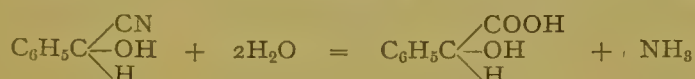


and while, therefore, it contains a hydroxyl group, like ethyl alcohol, it is a strong base by the virtue of the nitrogen atom in the pyridine nucleus. The basic properties of this group cause the esters—the tropëines—to be also basic bodies, and this is the reason for its behaviour with mercuric chloride. Homatropine is used in ophthalmic practice, because, while it dilates the pupil, like atropine and the other mydriatic alkaloids, its effects do not persist so long. Dilatation of the pupil is required for the examination of the interior structure of the eye, but after the examination the patient suffers considerable inconvenience from the entrance of too much light through the widely-dilated pupil; hence the shortening of the after-period of dilatation is an advantage. Homatropine is a homologue of atropine, the difference of  $\text{CH}_2$  in their formulæ being due to the homology of tropic and mandelic acids. Tropic acid is  $\alpha$ -phenyl

$\beta$ -hydroxy-propionic acid,  $\text{CH}_2^{\beta}(\text{OH})\cdot\text{CH}^{\alpha}(\text{C}_6\text{H}_5)\cdot\text{COOH}$ , while mandelic acid is phenyl-hydroxy-acetic acid,  $\text{CH}(\text{OH})(\text{C}_6\text{H}_5)\text{COOH}$ . It is so called because it was first obtained by the action of hydrochloric acid on amygdalin (Ger., *Mandel*, an almond). It is now made from benzaldehyde. Like other aldehydes, this combines with hydrocyanic acid to form an additive compound—a cyanhydrin, thus—



By boiling with hydrochloric acid the cyanide group is converted by hydrolysis into carboxyl, and mandelic acid is obtained—

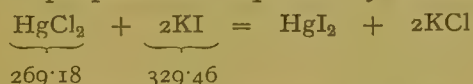


It should be carefully noted that homatropine does not occur naturally in any of the solanaceous plants, but is always an artificial product, like apomorphine.

[Dose.— $\frac{1}{80}$  to  $\frac{1}{20}$  grain.]

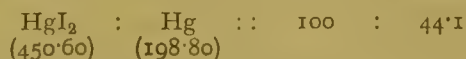
## Hydrargyri Iodidum Rubrum.

**Mercuric Iodide**,  $\text{HgI}_2$ , also known as biniodide or red iodide of mercury, may be prepared by mixing solutions of mercuric chloride and potassium iodide in the proportions required by the equation—



The precipitated mercuric iodide is collected, washed, and dried at a temperature not exceeding  $100^\circ \text{C}$ .

**Characters and Tests.**—Mercuric iodide is a crystalline powder of a vermilion colour, becoming yellow when a film of it, spread on a sheet of paper, is heated over a lamp. This change of colour is due to a change of crystalline form, *i.e.*, it is a physical and not a chemical one, since the yellow compound is identical in composition with the red crystalline form into which the yellow readily returns when rubbed. Mercuric iodide is almost insoluble in water, sparingly soluble in strong alcohol, freely soluble in ether. Mercurous iodide is distinguished from the mercuric iodide by its insolubility in ether, which will leave the former undissolved when a mixture of the two iodides is treated with this solvent. Mercuric iodide dissolves in solution of potassium iodide forming the complex potassium salt  $\text{K}_2\text{HgI}_4$ . It affords the reactions characteristic of mercuric compounds and of iodides. It volatilises at a temperature below redness, leaving only a minute fixed residue. When heated with excess of copper it is decomposed, the copper combining with the iodine while metallic mercury distils over and may be condensed and collected by passing its vapour into water. It should yield 43·5 to 44 per cent. of mercury, for—



**Notes.**—The solution of mercuric iodide in potassium iodide is known as Mayer's reagent and is a general precipitant of alkaloids. A solution of

potassium mercurio-iodide rendered strongly alkaline with potassium hydroxide constitutes Nessler's reagent which serves as a delicate test for minute quantities of ammonia. The fact that potassium hydroxide does not precipitate mercuric oxide when added to this solution favours the view that it contains a potassium salt in which the mercury constitutes part of the acidulous radical, and hence does not exhibit many of the reactions of mercury salts: compare iron in the ferrocyanides. The quantitative determination of mercury in mercury salts is usually effected by heating its compounds with lime; this, however, does not succeed with the iodide as some of the salt escapes decomposition and distils over with the metal; hence copper is used instead of lime. Compare Notes on "Hydrargyri Perchloridum." [Dose.— $\frac{1}{32}$  to  $\frac{1}{16}$  grain.]

## Hydrargyri Oleas.

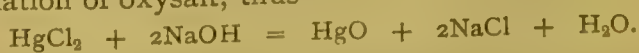
**Mercuric Oleate** is precipitated by mixing solutions of mercuric chloride and hard soap (sodium oleate). When soap is dissolved in water, it is partially hydrolysed and its solution is therefore alkaline and would precipitate a basic mercuric oleate. The Pharmacopœia directs the soap to be mixed with a little free oleic acid before solution in order to counteract this tendency to hydrolysis and neutralise the liberated alkali. The mixed solutions of soap and mercuric chloride are boiled, the resulting precipitate being washed with hot water and dried on a water-bath. It contains mercuric palmitate as well as oleate.

**Characters.**—Mercuric oleate is a substance of unctuous consistence, having a light greyish colour, liable to darken by keeping owing to reduction of the mercury salt to metallic mercury. It has a somewhat saponaceous odour.

**Notes.**—The precipitated oleate must be dried on the water-bath in order to remove adherent or combined water which would prevent the substance forming a clear solution with fatty ointment bases. An oleate of mercury was prepared according to the 1885 B.P., by dissolving mercuric oxide, 1 part, in oleic acid, 9 parts. Since 2 parts HgO combine with about 5 parts of oleic acid, this preparation contained mercuric oleate with uncombined oleic acid. It has been usual to state the strength of such preparations of mercuric oleate in terms of the mercuric oxide used in making them; thus, oleate of mercury, 10 per cent., indicated the preparation of the 1885 B.P., which contained the quantity of oleate corresponding to 10 per cent. of mercuric oxide. Mercuric oleate contains the equivalent of 24.35 per cent. of mercuric oxide.

## Hydrargyri Oxidum Flavum.

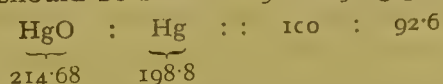
**Yellow Mercuric Oxide**, HgO, is prepared by adding solution of mercuric chloride to solution of sodium hydroxide, the latter being in excess, in order to prevent the formation of oxysalt, thus—



The precipitated mercuric oxide is collected, washed, and dried at a temperature not exceeding 30° C.



**Characters and Tests.**—Yellow mercuric oxide is a yellow powder, insoluble in water, but readily dissolved by hydrochloric acid, forming mercuric chloride; this solution affords the reactions characteristic of mercuric salts. Gently heated it assumes a red colour, this change being a physical one of the same nature as that exhibited by mercuric iodide. Heated to redness it is resolved into oxygen and mercury, leaving only a trace of non-volatile residue; the proportion of metallic mercury obtainable by this means, which can be collected and weighed, should be between 92 to 92.5 per cent., for—



**Notes.**—This oxide has exactly the same composition as the red oxide, both being mercuric oxide; the difference in colour is due to the difference in their physical condition, one being amorphous and the other crystalline. The hydroxide  $\text{Hg}(\text{OH})_2$  is unknown; possibly it is formed when sodium hydroxide is mixed with mercuric chloride solution, but decomposes immediately into oxide and water.

## Hydrargyri Oxidum Rubrum.

**Red Mercuric Oxide,  $\text{HgO}$ ,** is prepared by heating mercurous nitrate until orange-red vapours of nitric peroxide are no longer evolved—



The temperature at which mercurous nitrate is thus decomposed is considerably lower than that at which mercuric oxide is resolved into mercury and oxygen.

**Characters and Tests.**—Red mercuric oxide occurs in the form of orange-red crystalline scales or powder answering to the tests given under Hydrargyri Oxidum Flavum. When heated in a dry test tube it should not evolve orange vapours of nitric peroxide ( $\text{NO}_2$ ) showing that it contains no mercury nitrates.

**Notes.**—When metals are acted upon by nitric acid note that hydrogen is not evolved, as in the case of dilute sulphuric or hydrochloric acid. The reason for this is that the nascent hydrogen displaced by the metal from the acid molecule ( $\text{Hg} + 2\text{HNO}_3 = \text{Hg}(\text{NO}_3)_2 + 2\text{H}$ ) is oxidised by more nitric acid, which is consequently reduced, and yields one or more of the lower oxides of nitrogen. Nitric acid is derived from the pentoxide (nitric anhydride)  $\text{N}_2\text{O}_5 + \text{H}_2\text{O} = 2\text{HNO}_3$ . The composition of the gas obtained by the action of nitric acid upon metals depends partly upon the metal acted upon and partly upon the strength of acid used. Broadly speaking, it may be stated that with strong acid, nitric peroxide,  $\text{NO}_2$ , is chiefly obtained, while with diluted acid nitric oxide,  $\text{NO}$ , predominates. If the acid be very dilute, and particularly if zinc be the metal acted upon, the reduction of the nitric acid proceeds in part so far as the formation of ammonia. It must therefore be remembered that the equations usually given for the action of nitric acid on metals are only accomplished under certain conditions, and are never so simple as the equation shows. Thus in the process usually given for the preparation of

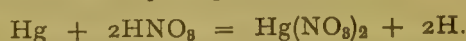
nitric oxide by the action of nitric acid diluted with two or three volumes of water on copper or mercury the equation given is—



As a matter of fact, while nitric oxide is, under these circumstances, the main constituent of the gas evolved, some nitric peroxide, as well as the still lower oxide, nitrous oxide,  $\text{N}_2\text{O}$ , is also obtained.

In the case of dilute sulphuric acid the hydrogen displaced by the metal is evolved, since no interaction takes place between nascent hydrogen and this dilute acid. All the apparently complex equations representing the action of metals upon nitric acid may be simplified by considering the reaction to occur in two stages.

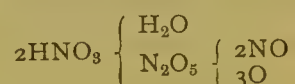
(i.) The displacement of the hydrogen by metal—



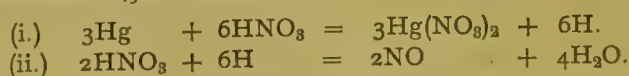
(ii.) The reduction of another portion of the nitric acid by this nascent hydrogen which is oxidised to water. If  $\text{NO}_2$  is obtained then—



For  $2\text{HNO}_3 = \text{H}_2\text{O} + \text{N}_2\text{O}_5$ , and  $\text{N}_2\text{O}_5$  will be reduced by two atoms of hydrogen with formation of  $2\text{NO}_2$  and  $\text{H}_2\text{O}$ . On the other hand, when nitric oxide is obtained, two molecules of nitric acid will require six atoms of hydrogen. The following representation will serve to make this clearer—



Since three atoms of oxygen combine with six atoms of hydrogen the equation written in two stages becomes—



In making the red oxide of mercury the first step is to prepare mercuric nitrate by dissolving mercury in excess of nitric acid. When heated this yields mercuric oxide—



By mixing the mercuric nitrate with more mercury, mercurous nitrate is formed, which also yields mercuric oxide when heated—

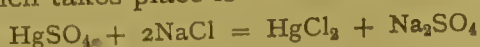


This obviously effects an economy in nitric acid, since the same amount suffices for the production, in the latter case, of twice as much oxide as in the former. The action of a low red heat upon mercuric oxide should be remembered as the classical experiment by which oxygen was first prepared. The absence of red vapours ( $\text{NO}_2$ ) when this is done shows that the oxide is free from nitrates.

## Hydrargyri Perchloridum.

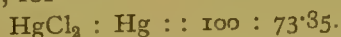
**Mercuric Chloride**,  $\text{HgCl}_2$ , also known as bichloride of mercury, corrosive sublimate, or perchloride of mercury, is obtained as a sublimate by heating a

mixture of mercuric sulphate, sodium chloride, and black oxide of manganese. The main reaction which takes place is—



Mercuric chloride vapour, however, dissociates partially into calomel and chlorine, and these re-combine on cooling to form the mercuric chloride again. Since, however, chlorine is so much lighter than calomel vapour, it will diffuse more freely than the latter from the mixed vapour; when, therefore, the vapours arrive at the region in the condenser where the temperature is sufficiently low for re-combination to take place, there will be a deficiency of chlorine and the condensed substance will consist of mercuric chloride containing calomel in proportion to the chlorine which has escaped. This result may be avoided by conducting the sublimation in presence of an excess of chlorine, and the addition of black oxide of manganese to the sublimation mixture is made with this intention, since the oxide reacts with some of the sodium chloride forming free chlorine. The manganese dioxide is thereby reduced to a lower oxide, which remains probably combined with the sodium oxide formed by the oxidation of the sodium chloride.

**Characters and Tests.**—Mercuric chloride occurs in heavy colourless masses of prismatic crystals, possessing a highly acrid metallic taste. It is officially stated to be soluble in 16 parts of cold water, 2 parts of boiling water, 3 parts of 90 per cent. alcohol, 4 parts of ether, and, on trituration, in 2 parts of cold glycerin. It affords the reactions characteristic of mercuric salts and of chlorides. When heated it sublimes without apparent decomposition, leaving only a trace of fixed residue. When heated with excess of lime it should yield 72·8 to 73·8 per cent. of metallic mercury. Theoretically, the pure salt should yield 73·85 per cent., for—



**Notes.**—The determination of metallic mercury in its compounds by heating them with lime is carried out in a manner similar to that adopted for the determination of carbon and hydrogen in organic compounds, the mercury being collected by having the open end of the combustion tube bent down and drawn out, so that its orifice dips beneath the surface of water contained in a dish, in which the mercury vapour condenses. Quicklime (*i.e.*, the oxide of calcium) is used, because the hydroxide evolves water when heated and, with some mercury compounds, the water vapour produces secondary reactions which interfere with the accuracy of the process. For the iodides of mercury, copper is used in place of lime (*vide* Hydrargyri Iodidum Rubrum). [Dose.— $\frac{1}{32}$  to  $\frac{1}{18}$  grain.]

## Hydrargyri Subchloridum.

**Mercurous Chloride, or Calomel,**  $\text{Hg}_2\text{Cl}_2$ , also known as Hydrargyri Chloridum or subchloride of mercury, is obtained as a sublimate when a mixture of mercurous sulphate and sodium chloride is heated—



Since the vapour of calomel dissociates into  $\text{Hg} + \text{HgCl}_2$ , the sublimate



obtained contains mercuric chloride, unless those vapours entirely recombine on condensation to mercurous chloride—a condition never realised in practice. The sublimate must, therefore, be washed with boiling water, to separate the soluble mercuric chloride from the calomel, which is insoluble in water.

**Characters and Tests.**—Mercurous chloride is a dull-white, heavy, and nearly tasteless powder, sometimes rendered yellowish by prolonged trituration, particularly if strong pressure be employed; insoluble in water, 90 per cent. alcohol, or ether, while mercuric chloride is soluble in all three fluids. It affords the reactions characteristic of mercurous salts and of chlorides. Hydrocyanic acid converts it into mercuric salt and a black powder readily yielding metallic mercury. It volatilises when sufficiently heated, leaving only a trace of fixed residue. Warm ether, with which it has been shaken, leaves, on evaporation, no residue. This test excludes the presence of mercuric chloride, ether being selected as the solvent, because  $\text{HgCl}_2$  is readily soluble in it, and the filtrate may be rapidly evaporated to dryness. Warmed with solution of potassium hydroxide, it is converted into the unstable black mercurous oxide—



and does not evolve ammonia. Evolution of ammonia would indicate the presence of ammoniated mercury. When heated with excess of lime, as described under “Hydrargyri Perchloridum,” it should yield 84.4 to 84.9 per cent. of metallic mercury, for—



**Notes.**—The formula for calomel is  $\text{Hg}_2\text{Cl}_2$ , and not  $\text{HgCl}$ , in spite of the fact that the vapour density observed for the substance is about 118, which would be in favour of the simpler formula. It has been shown, however, that the vapour produced when calomel is volatilised consists of Hg and  $\text{HgCl}_2$ ; *i.e.*, the vapour dissociates into mercury and mercuric chloride. There are two proofs of this dissociation: (1) the vapour from calomel contained in a heated porous clay tube does not diffuse as it would if it were the vapour of  $\text{HgCl}$ , since the vapour which passes through the porous wall contains more mercury than corresponds to this formula, (2) a stick of heated potassium hydroxide, placed in the vapour, forms the yellow oxide and not the black. This behaviour is readily explained by the assumption that the vapour contains Hg and  $\text{HgCl}_2$ ; for, in accordance with the law of diffusion, the vapour of mercury will diffuse more quickly than that of mercuric chloride. The formation of mercury and mercuric chloride is more in agreement with the formula  $\text{Hg}_2\text{Cl}_2$ , which readily dissociates—



than with the formula  $\text{HgCl}$ , which contains only one atom of mercury, and cannot, therefore, dissociate into two substances, each containing one atom of mercury. The Pharmacopœia describes calomel as obtained by sublimation. It can, however, be obtained by a modification of this method in which the vapour is mixed with air or steam, which causes it to be deposited in a very fine powder; and also by precipitation methods, such as the addition of sodium

chloride to a solution of mercurous nitrate; or by the action of reducing agents on mercuric chloride. The precipitated variety and the rapidly condensed powder differ only in the fineness of division from the calomel sublimed in mass and afterwards powdered, but they are both said to be much more active in consequence of this. The precipitated variety should not therefore be used, but the official description does not exclude the finely divided sublimate. The alleged variation in the potency of calomel may be due to its employment in a variable degree of fineness. [Dose.— $\frac{1}{2}$  to 5 grains.]

## Hydrargyrum.

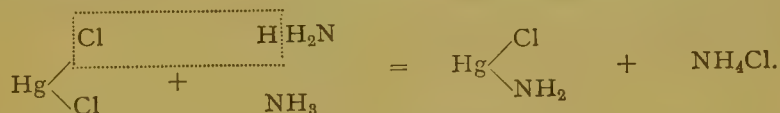
**Mercury** is a metal obtained from the native mercuric sulphide, cinnabar,  $\text{HgS}$ , which easily yields metallic mercury when roasted, or when heated with scrap iron or lime.

**Characters and Tests.**—Mercury is a silver-white fluid at ordinary temperatures, and easily divisible into spherical globules. Readily volatilises at a temperature below that of visible redness, leaving only an insignificant amount of fixed residue.

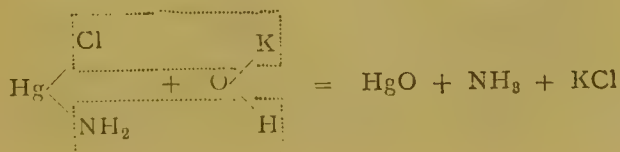
**Notes.**—Mercury solidifies at  $-39^{\circ}\text{C}$ . and boils at about  $360^{\circ}\text{C}$ . Since it remains fluid over this long range of temperature, and is easily obtained in a state of great purity, mercury is selected for the construction of thermometers; and, on account of its high density, serves for the construction of barometers. Owing to its physical properties it is a very valuable substance for many other applications in physical and chemical operations.

## Hydrargyrum Ammoniatum.

**Ammoniated Mercury**,  $\text{NH}_2\text{HgCl}$ , also known as ammonio-chloride of mercury, mercuric-ammonium chloride, or white precipitate, is obtained by adding a solution of mercuric chloride to diluted solution of ammonia. The precipitate is collected, washed with water, and dried below  $100^{\circ}\text{C}$ .—



**Characters and Tests.**—Ammoniated mercury is a white powder, insoluble in water, alcohol, and ether, while prolonged digestion with water converts it into a basic salt. Digested with solution of potassium hydroxide it evolves ammonia, and forms yellow mercuric oxide, which remains insoluble in the reaction mixture, while the filtrate from this (containing potassium chloride) will, after acidulation with nitric acid (to neutralise excess of potassium hydroxide), give a white precipitate of silver chloride on addition of silver nitrate solution—



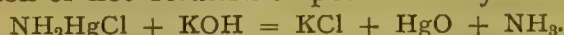
Boiled with solution of stannous chloride it is reduced, becoming grey, and eventually yielding globules of metallic mercury. It volatilises at a temperature below redness, without fusing, leaving only an insignificant amount of fixed residue, and is decomposed by the heat into mercurous chloride (or probably mercury and mercuric chloride), ammonia and nitrogen. Fusion before volatilisation indicates presence of "fusible" white precipitate, which may be obtained by an old process not now official. It has the composition  $\text{NH}_2\text{HgCl}$ ,  $\text{NH}_4\text{Cl}$ , and contains a smaller percentage of mercury than the present official compound (*vide* Notes). When heated with excess of lime, ammoniated mercury should yield between 78 and 79 per cent. of metallic mercury, for—

$$\begin{array}{ccccccc} \text{NH}_2\text{HgCl} & : & \text{Hg} & :: & 100 & : & 79\cdot54, \\ 249\cdot93 & & 198\cdot8 & & & & \end{array}$$

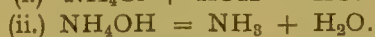
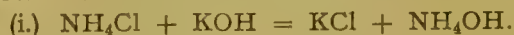
while the "fusible" white precipitate contains only 65·6 per cent. of mercury—

$$\begin{array}{ccccccc} \text{NH}_2\text{HgCl}, \text{NH}_4\text{Cl} & : & \text{Hg} & :: & 100 & : & 65\cdot6 \\ 303\cdot06 & & 198\cdot8 & & & & \end{array}$$

**Notes.**—Compare the action of ammonia with that of potash (or soda or lime) on solutions of perchloride of mercury. The latter gives the corresponding mercuric oxide,  $\text{HgO}$ , the hydroxide,  $\text{Hg}(\text{OH})$ , being unstable, and decomposing into  $\text{HgO}$  and  $\text{H}_2\text{O}$ , while with ammonia an insoluble complex metallo-amine, known as "white precipitate," is thrown down. This may be also regarded as ammonium chloride,  $\text{NH}_4\text{Cl}$ , in which two univalent hydrogen atoms are replaced by one divalent atom of (mercuric) mercury. The corresponding mercurous compound,  $\text{NH}_2\text{Hg}_2\text{Cl}$ , is met with in the usual course of qualitative analysis, when that portion of the first group precipitate insoluble in water, and containing  $\text{AgCl}$  and  $\text{Hg}_2\text{Cl}_2$ , is treated with ammonia. The  $\text{AgCl}$  is dissolved, while the calomel forms a mercurous amine, which is black, while the mercuric amine is white. The identity of white precipitate is completely revealed by the action of hot solution of potassium hydroxide—



This decomposition can be best understood by comparing the action of potassium hydroxide on ammonium chloride; the hydroxide is first formed, and that is decomposed into ammonia and water—



The hydroxide corresponding to the chloride of mercuric ammonium ( $\text{NH}_2\text{Hg})\text{OH}$  is, however, unknown, but it may be formed as an intermediate stage—



and then immediately decomposes—



Stannous chloride exerts its usual reducing action, the stannous becoming stannic chloride while metallic mercury is produced.

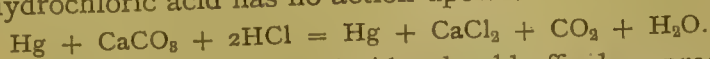
## Hydrargyrum cum Creta.

**Mercury with Chalk, or Grey Powder,** is produced by rubbing 1 part of mercury with 2 parts of prepared chalk, until metallic globules



cease to be visible to the naked eye, and the mixture acquires a uniform grey colour.

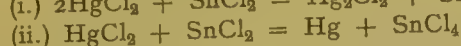
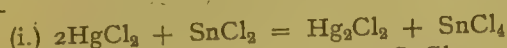
**Characters and Tests.**—Mercury with chalk is a powder of a light grey colour; free from grittiness; insoluble in water; treated with diluted hydrochloric acid the chalk dissolves, evolving carbonic anhydride and forming a solution of calcium chloride, whilst the mercury is left in a finely divided state, since diluted hydrochloric acid has no action upon it—



The filtrate, containing the calcium chloride, should afford no precipitate on the addition of stannous chloride. If, however, any mercuric oxide be present, that dissolves in the diluted hydrochloric acid—



and the filtrate will contain the soluble mercuric chloride so formed. It will therefore yield a white precipitate (mercurous chloride), or grey precipitate (finely divided metallic mercury), on the addition of stannous chloride, the product of the reaction depending chiefly upon the relative proportion of the reacting substances—



**Notes.**—The mercury in “grey powder” being finely divided is apt to become partially oxidised by keeping. Such an oxidised sample of “grey powder” would have an undesirably powerful action, and might be dangerous if given in the usual doses, because the oxide would dissolve in the hydrochloric acid of the gastric juice, producing mercuric chloride (corrosive sublimate), whereas dilute hydrochloric acid is entirely without action on metallic mercury. The medicinal action of finely divided insoluble mercury is very much milder than the corresponding weight of soluble perchloride. Another possible source of variation may arise from the mercury shaking down into the bottom of the stock bottle, owing to its density being greater than that of the chalk. It is thus very undesirable that “grey powders” should be kept in stock, weighed out and wrapped in paper, since that will accelerate the rate of oxidation by exposing a thin layer of the powder to the action of the air. Such powders have even become pink when kept for a prolonged period, and exhibited poisonous properties, owing to the formation of oxide. [*Dose.*—1 to 5 grains.]

## Hydrastis Rhizoma.

**Hydrastis Rhizome** is obtained from the Golden Seal, *Hydrastis canadensis*, Linné (N.O. Ranunculaceæ), a small herbaceous perennial plant, which is widely distributed in the United States and Canada, being found in moist, rich woodlands. It has a thick, fleshy, yellow rhizome, from which numerous long roots arise, and an erect, simple, pubescent stem, from 15 to 30 Cm. in height. The dried rhizome and roots alone are official, but the remains of stems are frequently found attached to the drug, which is collected in the autumn after the leaves have withered.

**Characters.**—Hydrastis rhizome is yellowish-brown, becoming darker with age, and occurs in rough, knotty and tortuous pieces from 12 to 38 Mm. long

and from 3 to 12 Mm. thick. They are usually simple, branched pieces being uncommon, though the rhizome frequently gives off short ascending branches, which terminate in cup-shaped scars left by the aerial stems of previous years. Those branches are found on the upper surface of the rhizome, and bear encircling scars of cataphyllary leaves, which are much more distinct than the scars found on the rhizome proper. Numerous thin, shrivelled, yellow roots are given off from the sides and under surface of the rhizome; as they are wiry and brittle they tend to break off, leaving small protuberances. The rhizome is hard, and breaks with a clean, short, resinous fracture, the surface thus exposed being smooth and of a dark brownish-yellow or greenish-yellow colour. A transverse section exhibits a comparatively thick bark and a ring of bright yellow, somewhat distant, narrow wood-bundles, surrounding a large pith. The root also has a dark bark and a small bright yellow wood. The slight, characteristic odour of the drug is due to the presence of volatile oil; the bitter taste is due to the alkaloids present. Ash-yield, 5 to 8 per cent.

**Notes.**—The distinctive characters of hydrastis rhizome are its yellow colour, the appearance of a transverse section, and the characteristic odour. Blood-root, from *Sanguinaria canadensis*, is usually of a dark reddish-brown colour, and a transverse section exhibits a more or less pronounced red colour, whilst there are no evident wood-bundles. The chief constituents of hydrastis rhizome are the alkaloids hydrastine (1.5 to 3.2 per cent.), berberine (about 3 per cent.), and canadine (tetrahydroberberine). Hydrastine crystallises in bitter, colourless, four-sided prisms, and is converted by oxidising agents into hydrastinine, an artificial alkaloid which forms a pale-yellow, crystalline hydrochloride; on dry distillation it yields trimethylamine and meconine. Berberine constitutes the colouring matter of the drug, and is obtainable in bitter yellow needles. Canadine occurs in the form of small white needles; when treated with iodine it yields berberine by reduction, and that base combines with the hydriodic acid produced, to form yellow berberine hydriodide. The name xanthopuccine has been applied to a base which is believed to be identical with canadine. Other constituents of the drug are resin, starch, and a small quantity of volatile oil, to which its odour is due. The name "hydrastin" has been given to a powdered alcoholic extract of hydrastis (Extractum Hydrastis Siccum), also to a mixture of substances obtained by precipitating an infusion of hydrastis with hydrochloric acid; these preparations contain the alkaloidal and resinous matters of the drug in variable proportions, and must not be confounded with the alkaloid hydrastine.

## Hyoscinae Hydrobromidum.

**Hyoscine (Scopolamine) Hydrobromide**, also known as hydrobromate of hyoscine— $C_{17}H_{21}NO_4 \cdot HBr \cdot 3H_2O$ —is the salt of an alkaloid occurring in the leaves of *Hyoscyamus niger*, Linné (N.O. Solanaceæ), the roots of *Scopola carniolica*, Jacquin (*Scopolia atropoides*, Link), and other species of *Scopola*, the flowers of *Datura alba*, Nees, and in other solanaceous plants. Hyoscine is an amorphous base, and is associated in all the plants mentioned with hyoscyamine and small

quantities of atropine, atropine also occurring in the roots of *S. carniolica*. The hyoscine can be extracted with ether in a reflux condenser, the drug being previously moistened with solution of potassium or sodium carbonate; the ethereal solution is subsequently shaken out with diluted sulphuric or hydrochloric acid, and the acid solution in turn shaken out with chloroform and ammonia. The chloroform solution, washed with water and then evaporated, leaves the alkaloids in the state of a brownish syrup, from which most of the hyoscyamine or atropine can be removed by treatment with ether, those two bases separating from the ethereal solution in the form of crystals. Any hyoscyamine or atropine that may remain can be removed by subsequent recrystallisation, and atropine, if present, can also be removed by crystallisation at a very low temperature, the pure hyoscine being left in the mother liquor, from which it can again be obtained as a varnish-like or oily liquid. The hydrobromide is prepared by neutralising the base with hydrobromic acid, evaporating the clear, filtered solution to a small bulk, adding strong alcohol to separate the crystals which form, and subsequently recrystallising from hot, strong alcohol.

**Characters and Tests.**—Hyoscine hydrobromide forms colourless, transparent, rhombic crystals, which are permanent in the air and odourless, but have an acrid, slightly bitter taste. It is officially stated to be soluble in 1 part of cold water, but the solubility of the commercial salt would be more correctly described as 1 in 4, and the pure salt is stated to be soluble to the extent of 1 in 9 only. It is also soluble in 13 (or 14) parts of 90 per cent. alcohol, but it is only very slightly soluble in ether or chloroform. It is further described as losing rather more than 12 per cent. of its weight when heated to 100° C., and then fusing to a viscid mass which becomes liquid at a temperature of 193° to 194° C. An aqueous solution of hyoscine hydrobromide yields a precipitate with test-solution of mercuric chloride, solution of iodine, or solution of potassium hydroxide, but not with solution of ammonia or solution of potassium bichromate. The statement that hyoscine hydrobromide forms with auric chloride a crystalline salt having a melting point of 198° C., may be taken to mean that when hyoscine is dissolved in excess of hydrochloric acid, or the hydrobromide converted into hydrochloride, and the solution precipitated with auric chloride, the resulting aurichloride has the melting point stated, and the base is thus differentiated from atropine and hyoscyamine. The reactions characteristic of hydrobromides are afforded by hyoscine hydrobromide, and its aqueous solution should be neutral to litmus, not slightly acid as the official description suggests. The salt should leave no residue when heated to redness with access of air, absence of mineral matter being thus proved.

**Notes.**—The chief source of hyoscine is *Datura alba*, the flowers of which yield 0.51 per cent. of the base, together with 0.03 per cent. of hyoscyamine and 0.01 per cent. of atropine. The alkaloid obtained from the leaves of *Hyoscyamus niger* contains 70 to 80 per cent. of hyoscyamine, accompanied by small quantities of its isomer atropine and of hyoscine or scopolamine. The roots of *Scopola carniolica* contain about 0.4 per cent. of total alkaloid, of which 0.03 per cent. is a mixture of hyoscine with atropine (*i*-scopolamine), or sometimes of three different alkaloids, whose composition is represented by the



formula  $C_{17}H_{21}NO_4$ . Commercial hyoscyne or scopolamine hydrobromide prepared from scopolia root appears to consist largely of the atropine salt, but the flowers of *Datura alba* yield hyoscyne of excellent quality free from atropine. The latter base is an optically inactive, crystalline isomer of hyoscyne,  $C_{17}H_{21}NO_4$ , melting at  $82^{\circ}$ - $83^{\circ}$  C., and dissolving in 38 parts of water at  $18^{\circ}$  C.; its aurichloride melts at  $201^{\circ}$ - $202^{\circ}$  C., while its dehydrated hydrobromide is optically inactive and melts at  $181^{\circ}$  C. On the other hand pure hyoscyne, as obtained from *Datura alba*, is an amorphous base, occurring as a varnish-like or oily liquid, and dissolving in 9 parts of water at  $18^{\circ}$  C.; its aurichloride melts at  $196^{\circ}$  to  $198^{\circ}$  C., while its dehydrated hydrobromide is lævo-rotatory and melts at  $192^{\circ}$  C. It would appear, therefore, that atropine differs from hyoscyne just as atropine differs from its isomer hyoscyamine. On hydrolysis both atropine and hyoscyne are converted into oscine,  $C_8H_{13}NO_2$ , and atropic acid,  $C_9H_8O_2$ , the formation of the latter being preceded by the formation of tropic acid,  $C_9H_{10}O_3$ ; similarly in the case of atropine and hyoscyamine, the products of hydrolysis are tropine,  $C_8H_{15}NO$ , and tropic acid, the latter being readily converted into atropic acid.

[Dose.— $\frac{1}{200}$  to  $\frac{1}{100}$  grain.]

## Hyoscyami Folia.

**Hyoscyamus** or **Henbane**. Leaves are obtained from *Hyoscyamus niger*, Linné (N.O. Solanaceæ), an erect herb distributed over the whole of Europe, extending to Persia and India, and cultivated in England. Two varieties of the plant—annual and biennial—are known, but the official drug must be collected from the flowering biennial plants only. During the first year of its growth, biennial henbane produces simply a rosette of large-stalked leaves, about 30 Cm. long; those are frequently collected and sold as “first biennial henbane.” The large branching stem does not make its appearance until the second year, and then attains a height of 1 metre or more. The leaves and flowering tops—“second biennial”—are collected soon after the plant has flowered, either with or without the smaller branches to which they are attached. The fresh leaves and flowers are used with the branches attached, or the carefully dried leaves and flowering tops, separated from the branches. The drug is largely imported from Germany.

**Characters.**—*Hyoscyamus* leaves vary considerably in size, but seldom exceed 25 Cm. in length. The lower or root leaves are the larger; they are stalked, but the upper leaves are sessile. The leaves are pale green in colour, with a broad, conspicuous midrib, and are furnished on both surfaces, but particularly near the veins on the under surface, with soft glandular hairs which secrete a resinous substance that causes the fresh leaves to feel unpleasantly clammy or sticky. Similar hairs occur on the sub-cylindrical branches. The leaves are arranged alternately on the stem or branches, are triangular-ovate or ovate-oblong in outline, acutely pointed, and without stipules. The margin is undulated, irregularly toothed, and sinuate or pinnatifid. The mesophyll of the leaf contains small prismatic crystals of calcium oxalate. The flowers arise from the axils of large, hairy and coarsely-

dentate leafy bracts, and are usually crowded together; they have a hairy, pitcher-shaped calyx and a yellowish gamopetalous corolla, with a network of purplish veins. The capsular fruit (pyxis) is two-celled and contains numerous seeds. The strong, characteristic tobacco-like odour of the fresh drug disappears to a large extent on drying, but the bitter and slightly acrid taste then becomes more pronounced. The ash-yield of the drug is about 8 to 12 per cent.

**Notes.**—The distinctive characters of biennial *hyoscyamus* are the sessile hairy leaves with sinuate-dentate outline and broad midrib, the purple veins of the corolla, and the shape of the ovary or fruit. When dried it occurs in commerce in irregularly-rounded or flattened masses, about 25 to 50 Mm. in diameter, in which can easily be identified the coarsely dentate hairy bracts, the yellowish corolla with purple veins, and the two-celled ovary with numerous ovules. The first year's leaves of biennial henbane are longer and narrower than those of the second year; also stalked and free from stem or flowers. The annual variety, on the other hand, has smaller leaves and a slender simple stem, while the corolla is paler and has less distinct purple veins. Annual henbane is nearly valueless, and the first year's leaves of biennial henbane are much less efficient medicinally, besides yielding less extractive, than the second year's leaves, which alone are official. The shape of the crystals of calcium oxalate found in the mesophyll distinguishes the leaves of *hyoscyamus* from those of *belladonna*, *digitalis*, *stramonium*, and other plants. The chief constituent of *hyoscyamus* is the crystalline alkaloid *hyoscyamine*, which is accompanied, on extraction, by small quantities of the isomeric *atropine*, which is also crystalline, and of *hyoscyne* or *scopolamine*, an amorphous base, which can be precipitated from its aqueous solution by concentrated potash or soda as an oily liquid, which forms crystalline salts. It is believed that *atropine* does not pre-exist in the plant, but is formed from *hyoscyamine* by the action of the heat and alkali used during the process of extraction. *Hyoscyamine* and *atropine* are isomeric bases, both of which yield *tropine* and *tropic acid* on hydrolysis; *hyoscyamine*, however, is optically active, and its aurichloride melts at  $160^{\circ}\text{C}$ ., while *atropine* is optically inactive and its aurichloride melts at  $137^{\circ}\text{C}$ . *Hyoscyne* is optically active, and its aurichloride melts at  $198^{\circ}\text{C}$ . The dried leaves, whether from wild or cultivated plants, usually contain from 0.05 to 0.14 per cent. of total alkaloid, but in exceptional cases the presence of as much as 0.27 per cent. of total alkaloid has been reported, three-fourths of this consisting of *hyoscyamine*. Other constituents of the leaves are a glucosidal bitter principle, named *hyoscypicrin*, *choline*, *mucilage*, *albumin*, *calcium oxalate*, and *potassium nitrate*.

## Hyoscyaminæ Sulphas.

**Hyoscyamine Sulphate** ( $\text{C}_{17}\text{H}_{23}\text{NO}_8$ ) $_2 \cdot \text{H}_2\text{SO}_4 \cdot 2\text{H}_2\text{O}$ , is the salt of an alkaloid occurring in the leaves of *Hyoscyamus niger*, Linné (Solanaceæ), the roots of *Scopola carniolica*, Jacquin, the flowers of *Datura alba*, Nees, and in other solanaceous plants. *Hyoscyamine* is a crystalline base, and is associated in

all the plants mentioned with atropine and hyoscine, atropine also occurring in the roots of *S. carniolica*. The hyoscyamine separates in crystalline form from the solution of mixed alkaloids obtained by extraction of drugs containing it with ether. It is difficult to obtain the base free from its isomer atropine, but it is distinguished from that alkaloid by its optical activity and the melting point of its aurichloride ( $160^{\circ}$  C.). Hyoscyamine sulphate is prepared from the base by neutralisation with diluted sulphuric acid and subsequent crystallisation.

**Characters and Tests.**—Hyoscyamine sulphate is a crystalline powder which is without odour, but possesses a bitter, acrid taste. As it is deliquescent, it should be kept in small, well-stoppered vials. The melting point of the compound is officially stated to be  $206^{\circ}$  C., but the pure salt melts at  $204^{\circ}$  C., and the commercial article at about  $200^{\circ}$  C. The salt is soluble in 0.5 part of water, 2.5 parts of 90 per cent. alcohol, and very slightly soluble in ether or chloroform. It affords the reactions characteristic of sulphates, and is distinguished from the salts of most other alkaloids by yielding no precipitate when solution of platinic chloride is added to an aqueous solution, acidulated with hydrochloric acid. A distinction from the corresponding atropine salt is afforded by the fact that an aqueous solution of hyoscyamine sulphate yields, with solution of auric chloride, a yellow precipitate which dissolves in boiling water acidulated with hydrochloric acid, and is again deposited, as the solution cools, in brilliant, golden-yellow scales. In addition, it should be noted that the melting point of hyoscyamine aurichloride is  $160^{\circ}$  C., while that of atropine aurichloride is  $137^{\circ}$  C. (see page 239). Absence of mineral impurity is indicated by hyoscyamine sulphate leaving no residue when heated to redness with access of air.

**Notes.**—Like its isomer atropine, hyoscyamine yields tropine and tropic acid on hydrolysis, and it can be converted into atropine by heat or by treatment with alkali, while the presence of hyoscyamine in a gold salt of atropine causes the latter base to be partially converted into hyoscyamine when the salt is kept. The free alkaloid, hyoscyamine, is more prone to change than its sulphate.

[Dose.— $\frac{1}{200}$  to  $\frac{1}{100}$  grain.]

## Infusa.

**Infusions** may be defined as preparations obtained by macerating a drug for a short time in water, and pouring off, or straining, the fluid from the insoluble marc. Note that this residue should *not* be pressed to obtain the maximum quantity of fluid. Such a procedure results in the production of a turbid infusion which cannot be filtered bright; for pressure expels from the tissue of the drug certain cell-contents of a mucilaginous or albuminous nature, which do not dissolve in water, but swell up in that fluid to form a colloid magma, which blocks up the pores of the filter. In preparing certain infusions, notably infusions of hops and senna, where the drug is bulky and very absorbent, the volume of infusion obtained by the official directions, *i.e.*, without pressure, is much less than that of the water poured on. It is necessary to bear this in mind when calculating the quantity required for dispensing a prescription



Boiling water is directed to be used when the nature of the drug allows, since hot water has greater solvent powers than cold, and also greater power of penetration. Obviously it is inadmissible for infusion of calumba, since calumba contains so much starch that an infusion prepared with boiling water would be a thick, mucilaginous, and unsightly preparation. With regard to quassia, the only other infusion made with cold water, it is said that cold water extracts the bitter principle as well as hot, which is probably true, since the amount of this bitter principle is small. Quassia being of a dry, woody nature, also offers fewer advantages than usual to the superior penetrative properties of hot water. It has been stated further that an infusion of quassia made with boiling water does not keep so well as a corresponding infusion made with cold water. This is a doubtful point, concerning which further definite experimental information is required. From the nature of the menstruum—water—in which so many of the proximate organic constituents of vegetable tissue are soluble, such as gum, sugar, proteid, organic acids, etc., the infusions contain numerous other organic substances beside the active principles which are extracted by the water, and they form favourable nutrient fluids for the development of moulds and various forms of bacteria. They are therefore liable to putrefactive decomposition, and cannot, under ordinary conditions, be kept without alteration for more than a few days. To obviate the necessity for preparing infusions whenever required for dispensing a prescription, so-called “concentrated infusions” are sometimes used. Concentration of an infusion by evaporation would entirely alter, and in most cases deteriorate its flavour, odour, and medicinal virtue. As a matter of fact the so-called concentrated infusions are prepared either by macerating a correspondingly increased quantity of drug, when the total quantity is small, as in the case of digitalis, or by a process of percolation with cold water, or dilute alcohol, the fluid so obtained being preserved from decomposition by the addition of about 20 per cent. of rectified spirit. However convenient such preparations may be, their use, in place of freshly prepared infusions, should not be countenanced by the pharmacist jealous of his reputation. The chief points to which attention should be paid in preparing infusions are: (1) the state of subdivision of the drug, (2) temperature of the water, and (3) the time for infusing. The last is most important, since prolongation of infusion beyond the specified time results in some cases in a fluid having a taste, aroma, and appearance greatly varying from those of the correctly prepared infusion. This change of properties is seen to a marked degree in “overdrawn” infusion of tea leaves. It should be noted that the infusions are not intended to contain the whole of the substances present in a given drug which are soluble in the menstruum, as is the case, *e.g.*, in fluid extracts and tinctures, but only those extractable under the given conditions of time and temperature. The drugs to which the process may most suitably be applied are those having aromatic constituents which are the active principles or which accompany them. Another necessary condition is, naturally, that the active principles shall be sufficiently soluble in water to yield an infusion having the desired medicinal activity. With drugs complying with these conditions the infusion often constitutes the most agreeable form of preparation, and may be used as a

vehicle for the administration of other remedies, either as a flavouring agent, adjuvant, or corrective. There are twenty-two official infusions, and the dose of each is  $\frac{1}{2}$  to 1 fluid ounce, except in the following cases :—Digitalis, 2 to 4 fluid ounces ; buchu, cusparia, ergot, hops, and broom, each 1 to 2 fluid ounces ; senna (as a draught), 2 fluid ounces.

Infusum.	INFUSION OF	TIME OF INFUSION.	PROPORTION OF DRUG TO WATER.
Aurantii	ORANGE PEEL	$\frac{1}{4}$ hour	1 to 20
Aurantii Comp.	ORANGE PEEL (Comp.)	$\frac{1}{4}$ "	1 " 40
Buchu	BUCHU	$\frac{1}{4}$ "	1 " 20
Calumbæ	CALUMBA	$\frac{1}{2}$ "	1 " 20
Caryophylli	CLOVES	$\frac{1}{4}$ "	1 " 40
Cascarillæ	CASCARILLA	$\frac{1}{4}$ "	1 " 20
Chirataë	CHIRETTA	$\frac{1}{4}$ "	1 " 20
Cinchonæ Acidum	CINCHONA (Acid)	1 "	1 " 20
Cuspariæ	CUSPARIA	$\frac{1}{4}$ "	1 " 20
Digitalis	DIGITALIS	$\frac{1}{4}$ "	1 " 147
Ergotæ	ERGOT	$\frac{1}{4}$ "	1 " 20
Gentianæ Comp.	GENTIAN (Compound)	$\frac{1}{4}$ "	1 " 80
Krameriæ	KRAMERIA or RHATANY	$\frac{1}{4}$ "	1 " 20
Lupuli	HOPS	$\frac{1}{4}$ "	1 " 20
Quassiaë	QUASSIA	$\frac{1}{4}$ "	1 " 100
Rhei	RHUBARB	$\frac{1}{4}$ "	1 " 20
Rosæ Acidum	ROSES (Acid)	$\frac{1}{4}$ "	1 " 40
Scoparii	BROOM	$\frac{1}{4}$ "	1 " 10
Senegæ	SENEGA	$\frac{1}{2}$ "	1 " 20
Sennæ	SENNA	$\frac{1}{4}$ "	1 " 10
Serpentariæ	SERPENTARY	$\frac{1}{4}$ "	1 " 20
Uvæ Ursi	BEARBERRY	$\frac{1}{4}$ "	1 " 20

The drugs are used in a state of sub-division which allows of a satisfactory extraction by water and the removal of the marc after infusion ; fine powders are, for this reason, to be excluded. Acid cinchona infusion contains some aromatic sulphuric acid to facilitate the extraction of the alkaloids, while the acid infusion of roses is rendered acid, in order to produce a bright red infusion.

## Injectiones Hypodermicæ.

**Hypodermic Injections** are fluids prepared for the purpose of injection, by means of a syringe and needle, into the subcutaneous tissues. For the most part they consist of solutions of various bodies in water, glycerin, or oil ; and in order to avoid irritation at the seat of injection they should be as nearly neutral in reaction as possible, since both acids and alkalies give rise to local inflammation when applied to living tissues. Water is more frequently used as the solvent than glycerin or oil, and is alone employed in the official hypodermic injections ; all three fluids should be previously sterilised by heat—water by boiling for five minutes, and glycerin and oil by heating them in an oven to about

120° C. for half an hour. Distilled water collected and stored without special precautions is never sterile. It contains micro-organisms derived from the air and the appliances with which it is brought in contact. These organisms increase very slowly or not at all in good distilled water, owing to the scanty amount of nutrient materials available for their development. Even here, however, they sometimes increase in number, forming colonies or mycelia, which give the water a cloudy appearance and bad odour. Their increase takes place rapidly if organic substances capable of being used for their nourishment are dissolved in the water. Weak solutions of sugar, or organic salts, alkaloids, and particularly complex organic mixtures, like extract of ergot, favour their development. This is, of course, accompanied by destruction of the added organic substances, and the formation of metabolic or excretory substance, derived therefrom, having in many cases an injurious or irritant action on the tissues when injected hypodermically. Even if the injurious effects are not marked, the strength of such solutions will have been diminished by the consumption of the dissolved substances. The micro-organisms in distilled water prepared under ordinary laboratory conditions will (except in extremely rare cases where infection with specific disease organisms may have taken place) belong to the non-pathogenic class; hence the comparatively small number to be found in a few minims of freshly distilled water are not of much importance. A hypodermic injection made with such water is, however, liable to the deterioration already described. For this reason it is desirable to destroy the organisms present in the water before using it as a vehicle for injections, and protect the finished product from the access of fresh organisms during the time it is kept. In order to sterilise the water (*i.e.*, to kill the micro-organisms contained in it) used for preparing the four official hypodermic injections, the Pharmacopœia directs that it shall be previously boiled. No time is stated for the duration of the boiling, but three to five minutes is practically sufficient. The best plan to adopt is to place in a flask considerably more water than is required for the actual volume of injection to be prepared. The neck of the flask should be plugged with cotton wool uniformly and fairly tightly packed to the depth of about one inch. During the ebullition the plug allows steam to escape, and prevents the entry of organisms from the air during the subsequent period of cooling. All the utensils, after being thoroughly cleansed in the ordinary way, as well as the bottle intended for the reception of the injection, should be rinsed with some sterilised water taken from the flask, in order to diminish the risk of infection as much as possible. An injection prepared in this manner will be found to remain good much longer than one prepared without the precautions indicated. Unavoidable opportunities of infection will of course occur each time the containing vessel is opened. Antiseptic substances, which are either toxic or have an irritant action upon the subcutaneous tissues, can obviously only be applied here to a limited extent for preservative purposes. In preparing hypodermic injections, other than the official ones, the volume of fluid for each injection should, if possible, be kept between 5 and 10 minims, since it is difficult to measure accurately quantities of less than 5 minims, and more than



10 minims causes discomfort, owing to local distension of the tissues. The action of remedies by subcutaneous injection is more prompt and powerful than when administered by the mouth, since by the former method the injected substance is rapidly taken into the blood stream by the capillary blood vessels and conveyed to the organs of the body. There are four hypodermic injections official.

**Injectio Apomorphinæ Hypodermica.** HYPODERMIC INJECTION OF APOMORPHINE.

Contains 1 part of apomorphine hydrochloride and 1 fluid part of diluted hydrochloric acid, dissolved in 100 fluid parts of freshly boiled and cooled water. [Dose.—5 to 10 minims.

**Injectio Cocainæ Hypodermica.** HYPODERMIC INJECTION OF COCAINE.

Contains 1 part of cocaine hydrochloride in 10 fluid parts with a small quantity of salicylic acid as preservative. [Dose.—2 to 5 minims.

**Injectio Ergotæ Hypodermica.** HYPODERMIC INJECTION OF ERGOT OR ERGOTIN.

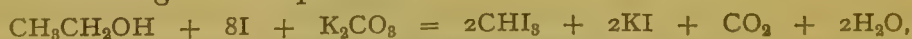
Contains 1 part of extract of ergot in 3 fluid parts with a small quantity of phenol as preservative. [Dose.—3 to 10 minims.

**Injectio Morphinæ Hypodermica.** HYPODERMIC INJECTION OF MORPHINE.

Contains 1 part of morphine tartrate in 20 fluid parts. The tartrate is employed in preference to the other official morphine salts because it is more stable than the acetate, and the hydrochloride is not sufficiently soluble in water to yield a 1 in 20 solution. [Dose.—2 to 5 minims.

## Iodoformum.

**Iodoform** or **Tri-Iodo-Methane**,  $\text{CHI}_3$ , is produced by the action of iodine upon alcohol in presence of solution of potassium or sodium carbonate, the reacting substances being mixed and warmed to about  $70^\circ \text{C}$ . An aqueous solution of potassium iodide, carbonate, and alcohol submitted to electrolysis, also yields iodoform, the iodide being decomposed, and the iodine, liberated at the anode, reacting with the alcohol in presence of the alkali. The reactions leading to the formation of iodoform are complicated but probably similar to those already described under “Chloral Hydras” and “Chloroformum.” By the first process only a comparatively small proportion of the iodine employed is obtained as iodoform according to the equation—



the rest forming alkali iodide and iodate which remain in the solution from which the iodoform separates. From this the iodine may be recovered by working it up into potassium or sodium iodide; or by passing chlorine into it some of the iodine may be liberated, and will then give a further yield of iodoform with more alcohol.

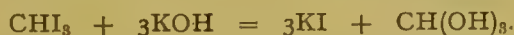
**Characters and Tests.**—Iodoform forms shining, lemon-yellow, small hexagonal crystals; having, especially when examined by the microscope, very characteristic forms; somewhat unctuous to the touch; having a persistent and disagreeable odour and taste. Very slightly soluble in cold water, soluble in

80 parts of cold or 10 parts of boiling 90 per cent. alcohol, in 5 parts of cold ether, soluble also in chloroform, carbon bisulphide, or fixed and volatile oils, and sparingly in benzol; the solutions do not affect litmus. When heated it melts to a brown liquid and at a higher temperature gives off vapours of iodine and hydriodic acid, and leaves a black carbonaceous residue which entirely disappears on continued incineration. When warmed with an *alcoholic* solution of potassium hydroxide it is decomposed with formation of potassium iodide and formate—

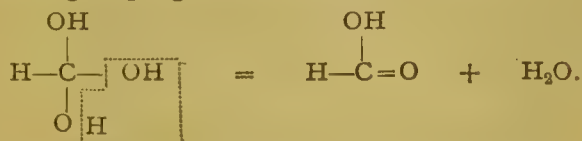


and the filtrate when acidulated with nitric acid will therefore become brown from the liberation of iodine from the iodide. The brown substance may be proved to be iodine by the addition of starch mucilage which forms the characteristic blue compound with iodine. Since this blue compound is dissociated when heated, the liquid must be cooled before adding the starch mucilage. When shaken with water and the mixture filtered, the filtrate should be colourless and tasteless, since iodoform is so slightly soluble; a yellow filtrate would indicate adulteration with yellow dyes, while picric acid, if present, will give a yellow filtrate having a bitter taste. Iodoform should be free from iodides. Iodoform is only very slowly decomposed by aqueous caustic potash, but a boiling alcoholic solution of potash rapidly produces formate and iodide of potassium.

**Notes.**—The last-mentioned reaction is of interest because it constitutes a general method of synthesis for organic acids. It might be expected that, since potassium hydroxide exchanges (OH) for I, the (OH) groups would replace the iodine, thus—



It is not possible, however, to obtain compounds containing more than one (OH) group attached to each carbon atom (see note on Chloral Hydras). When an attempt is made to do so, as in the above reaction, water is split off and a rearrangement of the atomic grouping occurs, thus—



The body  $\text{CH(OH)}_3$  is called orthoformic acid, and is only known in the form of its esters, the free acid always decomposing into ordinary formic acid and water.

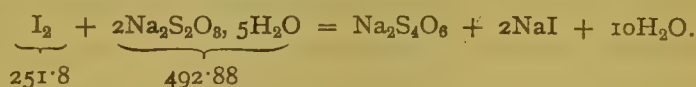
[Dose.— $\frac{1}{2}$  to 3 grains.]

## Iodum.

**Iodine** is a solid non-metallic element obtained from the ashes of seaweeds and from native iodides and iodates. Sea water contains only about 1 part of iodine in 300,000, but certain species of seaweeds possess the faculty of withdrawing and retaining the iodides in their tissues, and contain in some cases, in the dried state, 3 or 4 parts of iodine per 1,000. The ash obtained by burning these dried seaweeds is known as “kelp”; by lixiviation with water and fractional crystallisation it yields crude iodides (chiefly sodium iodide),

from which the iodine may be obtained by the action of manganese dioxide and sulphuric acid. In some districts the seaweed is subjected to destructive distillation, tarry products having commercial value being thus obtained, in addition to the ash. Iodine is contained in the mother-liquor from the crystallisation of the native Chili saltpetre,  $\text{NaNO}_3$ , chiefly as sodium iodate.

**Characters and Tests.**—Iodine occurs in rhombic prisms or octahedrons of the trimetric system, of a peculiar odour, dark colour, and metallic lustre, which, even when gently heated, yield a violet-coloured vapour; soluble in about 5,000 parts of water, freely soluble in 90 per cent. alcohol, ether, and chloroform. It dissolves also in potassium iodide solutions, forming probably a weak compound,  $\text{KI}_3$ , since immiscible solvents like chloroform and carbon bisulphide do not withdraw it from the solution when agitated with it. The aqueous solution strikes a deep blue colour with starch mucilage forming a compound, the so-called iodide of starch, the blue liquid becoming colourless when heated, and the colour reappearing on cooling, though with diminished intensity. The effect is due to the dissociation of the starch iodide, and therefore in applying the starch reaction to detect iodine the liquids should be cold. Iodine should sublime without residue, and the portion that first comes over should not include any slender colourless prisms of iodine cyanide,  $\text{ICN}$ . Cyanogen compounds originate from the combination of carbon and nitrogen of the organic substances in presence of the alkali formed from the organic salts during the combustion or distillation of the seaweed. When dissolved in chloroform iodine should form a perfectly clear solution; any adherent moisture will cause the solution to be turbid owing to the slight solubility of water in chloroform. One gramme dissolved in 50 C.c. of water containing 2 grammes of potassium iodide require for decolorisation at least 78.4 C.c. volumetric solution sodium thiosulphate.



The official volumetric solution of sodium thiosulphate contains 24.644 grammes per litre  $\left(\frac{\text{Na}_2\text{S}_2\text{O}_3, 5\text{H}_2\text{O}}{10}\right)$  and this is equivalent to 12.59 grammes iodine  $\left(\frac{125.9}{10}\right)$ ; it is therefore decinormal, since 125.9 grammes of iodine are equivalent to 1 gramme of hydrogen,

∴ 1 litre N/10 volumetric solution sodium thiosulphate =	12.59 grammes iodine
∴ 1 C.c. " " " " " =	0.01259 "
∴ 78.4 C.c. " " " " " =	0.01259 × 78.4 "
	= 0.987 "

**Notes.**—In iodine titrations the termination of the reaction is indicated by the disappearance of the brown colour of the free iodine. A more delicate indication is furnished by the addition of starch mucilage, since the blue colour of the starch iodide is more easily distinguished than the less intense brown of an equivalent quantity of free iodine. It is best to add the starch towards the end of the reaction, when the solution is pale yellow: the blue compound then produced reacts sharply with the thiosulphate, but if the starch be added at



the beginning a blackish flocculent precipitate is produced which does not clear up so satisfactorily at the termination of the titration. Iodine melts at  $114^{\circ}\text{C}.$ , boils at  $184^{\circ}\text{C}.$ , and has a specific gravity of 4.95.

## Ipecacuanhæ Radix.

**Ipecacuanha Root** is obtained from *Psychotria Ipecacuanha*, Stokes (N.O. Rubiaceæ), a small shrubby plant, about 30 Cm. high, which is found in most parts of Brazil, but the root is chiefly collected in the interior, in the province of Matto Grosso. The root of cultivated plants has also been imported from Johore, near Singapore. The slender stem of the plant grows partly underground, and is often procumbent at the base, the lower portion being knotted, with fibrous rootlets frequently proceeding from the knots. Some of the rootlets develop an abnormally thick bark, in which much starch is deposited, and those thickened roots, when collected and dried, constitute the official drug.

**Characters.**—Ipecacuanha root occurs in slender and somewhat tortuous, closely annulated pieces, which seldom exceed 15 Cm. in length and 6 Mm. in thickness. It varies in colour from very dark brown to dark brick-red, the latter colour being partly due to adhering particles of earth. The bark is constricted at short intervals, so as to give the root the appearance of a number of discs somewhat irregularly strung together. The constrictions are sometimes quite shallow in Brazilian or Rio ipecacuanha, but they may penetrate nearly to the wood; they never assume the form of narrow merging ridges, as in the case of Cartagena (Colombian) ipecacuanha. The root is hard, and breaks with a very short fracture, the fractured surface exhibiting a thick, dark grey bark or cortex, with a horny, resinous, or starchy appearance, and a small dense wood, in which no distinct pores or pith can be discerned when examined with a lens. Microscopical examination of the cortex reveals the presence of small compound starch grains and acicular crystals (raphides) of calcium oxalate; the wood should contain no vessels. The slight odour of ipecacuanha appears to be due to the presence of fatty matter and a volatile oil; the bitter taste is due to the glucoside and alkaloids present.

**Notes.**—The distinctive characters of Brazilian or Rio ipecacuanha root are the closely approximated disc-like annulations, the thick starchy bark, and the small dense wood. Pieces of the stem are slender, longitudinally striated, and exhibit no annulations, while transverse sections exhibit a thin bark, surrounding a ring of wood which encloses a distinct pith. Cartagena or Colombian ipecacuanha, which is supposed to be obtained from *Psychotria acuminata*, is usually thicker than Brazilian, occurs in shorter and more brittle pieces, and has distinct, somewhat distant, narrow, raised ridges, instead of annulations; the starch grains are also rather larger than those of Brazilian ipecacuanha. Other emetic roots sometimes offered as substitutes for ipecacuanha differ considerably in appearance from Brazilian ipecacuanha. Thus, East Indian ipecacuanha (? *Cryptocoryne spiralis*) exhibits a typically monocotyledonous structure in transverse sections, scattered bundles running through a parenchymatous stele, which is surrounded by a white starchy

bark. Undulated ipecacuanha (*Richardsonia scabra*) is only slightly annulated, the wood is porous, and the starchy bark often has a violet colour. Lesser striated ipecacuanha (*Richardsonia* sp.) is dark purplish-brown in colour, longitudinally wrinkled, not annulated, and has porous wood. Greater striated ipecacuanha (*Psychotria emetica*) closely resembles the preceding, but contains no starch, and has dense wood. White ipecacuanha (*Ionidium ipecacuanha*) is greyish-white or yellowish in colour, and is also free from starch. The official drug contains from 2 to 3 per cent. of total alkaloid, of which about 72 per cent. is emetine, 26 per cent. cephaeline, and 2 per cent. consists of psychotrine. Emetine (melting point  $68^{\circ}$  C.) occurs as an amorphous white powder, but it forms crystalline salts; cephaeline (melting point  $96^{\circ}$ - $98^{\circ}$  C.) can be obtained in white silky needles, and psychotrine (melting point  $138^{\circ}$  C.) also occurs in crystalline form. Other constituents of ipecacuanha root are a crystalline saponin-like glucoside, an amorphous bitter glucoside named ipecacuanhic acid, choline, resin, pectin, starch, sugar, calcium oxalate, odorous fatty matter, and a disagreeable-smelling volatile oil. Pieces of the stem found mixed with the root contain less than 2 per cent. of total alkaloid, and they should therefore be rejected. Cartagena ipecacuanha contains rather more total alkaloid than the Brazilian, but 57 per cent. of that consists of cephaeline, and only 40 per cent. is emetine. As the expectorant property of the drug appears to be due to emetine, whilst cephaeline produces the emetic effect, it is of importance that Cartagena ipecacuanha should not be substituted for Brazilian, since the proportions of the two alkaloids are reversed in the former. The substitution is more likely to occur in powdered ipecacuanha, and can be detected by the aid of the microscope. Substitutes containing no emetine give no colour reaction when treated with hydrochloric acid and potassium chlorate. If, however, 0.5 gramme of finely-powdered root containing emetine be mixed with 20 C.c. of strong hydrochloric acid and 5 C.c. of water, 2 C.c. of the clear liquid obtained on filtration should assume a yellow colour, which slowly changes to red, on adding 0.01 Gm. of potassium chlorate. East Indian ipecacuanha contains a minute quantity of an alkaloidal substance, which is distinct from the alkaloids of true ipecacuanha, as is also probably the emetic principle of white ipecacuanha; the undulated and striated ipecacuanhas all contain more or less of an alkaloid which is supposed to be emetine, but the presence of cephaeline in those roots has not yet been recorded.

[Dose.— $\frac{1}{4}$  to 2 grains (expectorant); 15 to 30 grains (emetic).]

## Jaborandi Folia.

**Jaborandi Leaves**, so called, are the dried leaflets of *Pilocarpus Jaborandi*, Holmes (N.O. Rutaceæ), a Brazilian shrub which produces large, impari-pinnate, compound leaves with three or four pairs of leaflets. Those are chiefly exported from Pernambuco and Ceara. The leaflets, as they arrive in this country, are mixed with the petioles and occasional small fruits, and they are also liable to be mixed with the leaves of other varieties of jaborandi, which are largely imported and sometimes substituted for the official leaves.



**Characters.**—Jaborandi leaflets are dull brownish-green in colour, leathery in texture, oval-oblong or oblong-lanceolate in outline, and usually from 6 to 10 Cm. in length. They have short stalks, entire and revolute margins, are blunt and emarginate at the apex, and for the most part are unequal at the base. When mature the leaflets are glabrous, though a few scattered hairs may occur on the under surface, and the lateral veinlets are distinctly prominent on the upper surface. Numerous large oil-glands in the mesophyll are readily visible when the leaflets are examined by transmitted light; the volatile oil they contain causes the drug to give off a slight aromatic odour when bruised and imparts a slight pungency to the taste, which is also somewhat bitter owing to the presence of alkaloids, one of which—pilocarpine—induces an increased flow of saliva.

**Notes.**—The distinctive characters of the official (Pernambuco) jaborandi leaflets are the presence of oil-glands, the entire margin, emarginate apex, inequality at the base, the prominence of the veinlets on the brownish-green upper surface, and the practically glabrous under surface. Numerous other varieties of jaborandi occur in commerce, but all differ in important respects from the official drug. Thus, the leaflets of *P. microphyllus*, Stapf (Maranham jaborandi), are usually ovate in outline, deeply emarginate at the apex, do not exceed 2.5 to 4 Cm. in length, and the rachis is slightly winged. The leaflets of *P. pennatifolius*, Lemaire (Paraguay jaborandi), are paler than those of *P. jaborandi*, more of a greyish-green colour, and less leathery in texture, whilst the veinlets are not prominent on the upper surface and the base is usually equal and tapering. The leaflets of *P. trachylophus*, Holmes (Ceara jaborandi), are smaller than the official variety, though larger than those of *P. microphyllus*; they are dark olive-green and have a few scattered hairs on the upper surface, while yellowish-green and clothed with short curved hairs on the under surface. Aracati jaborandi, supposed to be obtained from *P. spicatus*, resembles bay leaves in size and shape; the veins are scarcely visible, the outline is lanceolate and the petiole short and twisted. The large thin grey papery leaves of *Piper jaborandi*, Vellozo, have also been imported as jaborandi; they taper towards both base and apex, and are usually mixed with the stems, which are swollen at the nodes. Rio Janeiro jaborandi, from *P. selleanus*, Engler, consists of leaflets which are more obovate in outline than those of other varieties, and the veinlets are not prominent on the upper surface like those of *P. jaborandi*. Cherry-laurel leaves differ from jaborandi leaflets in having a serrated margin, pointed apex, and no oil-glands; bay leaves are pointed at the apex and equal at the base, with wavy margins. Jaborandi leaflets contain from 0.5 to 1 per cent. of amorphous alkaloids, consisting chiefly of pilocarpine,  $C_{11}H_{16}O_2N_2$ , together with small quantities of an isomeric base named isopilocarpine and of a third alkaloid named pilocarpidine,  $C_{10}H_{14}O_2N_2$ . The name jaborine has been applied to a mixture of alkaloidal and colouring matters, which was supposed to constitute a fourth alkaloid of jaborandi leaves. Pilocarpine and isopilocarpine are syrupy liquids; they cannot be obtained in crystals, and the statement that pilocarpine can be converted into pilocarpidine and jaborine by the action of hydrochloric acid or of barium hydroxide is incorrect. Pilocarpine is optically



active and forms crystalline salts. Isopilocarpine, though present in jaborandi leaves in small quantity, is chiefly formed from pilocarpine during the process of extraction, in a similar manner to that by which hyoscyamine is converted into atropine. It can be formed from pilocarpine by the action of heat or alkalies, and is very similar to that base in its physical and chemical properties, though it is optically inactive, except in neutral solution. Pilocarpidine has been found in Pernambuco jaborandi only; it occurs as a syrupy liquid and forms crystalline salts, but it differs in various ways from pilocarpine and isopilocarpine. Other constituents of jaborandi leaflets are tannin, resin, and from 0.2 to 1.0 per cent. of a volatile oil (specific gravity, 0.865 to 0.895) containing dipentene (pilocarpene), a crystalline hydrocarbon, and various ketones.

## Jalapa.

**Jalap** consists of the dried tubercles of *Ipomœa Purga*, Hayne (N.O. Convolvulaceæ), a climbing plant, indigenous to the eastern slopes of the Mexican Andes, which has been successfully cultivated in India and Jamaica. The plant gives off slender runners, which bear scaly, cataphyllary leaves at intervals, and in the axils of those leaves are buds below which fibrous roots are produced. Some of the roots thicken and become tuberous; those are collected and dried over fires, the larger ones being cut longitudinally to allow moisture to escape. They are white and fleshy internally when fresh, but darken in colour on drying. The drug is chiefly imported from Vera Cruz.

**Characters and Tests.**—Jalap root occurs in irregularly oblong, ovoid, napiform, or fusiform pieces, varying in length from 2.5 to 7.5 Cm. or more, the larger pieces being frequently incised. The pieces are hard, compact and heavy, and taper towards the lower extremity, where the slender part of the root has been broken off. The dark-brown outer surface of the roots is furrowed, wrinkled, and marked with numerous small, paler, transverse scars, which appear to correspond with lenticels; internally, the roots are of a yellowish-grey to dingy-brown colour, and very tough or horny. A transverse section usually exhibits irregular dark lines—due to the formation of secondary cambiums—which are often arranged concentrically. Numerous compound starch grains and clustered crystals of calcium oxalate are seen when the section is examined with a lens or microscope; dark resin cells are also visible, especially in the cortical portion, but woody tissue is not easily distinguished. The characteristic odour of the drug appears to be partly due to the smoke from the fire over which the roots have been dried, but is probably chiefly due to the resin they contain. The sweet taste at first perceived may be attributed to the sugar present, but the disagreeable acrid after-taste is due to the resin. When assayed by the process described under *Jalapæ Resina*, jalap should yield from 9 to 11 per cent. of dark-brown opaque resin, which is easily soluble in 90 per cent. alcohol, but only 10 per cent. of which is soluble in ether.

**Notes.**—The distinctive characters of jalap are the presence of lenticels, freedom from convolutions and radiate structure, and the comparative insolubility of its resin in ether. The roots of Tampico jalap (*Ipomœa simulans*)

are irregular in shape, have a remarkably convoluted surface, do not exhibit lenticels, and yield about 10 per cent. of resin (tampicin) which is completely soluble in ether and probably identical with scammony resin and the ether-soluble resin (scammonin) of true jalap. Orizaba or male jalap (*I. orizabensis*) occurs in irregular, rectangular, or block-like pieces which have formed part of very large roots, or in small spindle-shaped, entire roots, transverse sections of which exhibit a radiate structure, whilst numerous thick bundles of vessels project as woody fibres from the fractured surface; it contains about 12 per cent. of "orizabin," a resin identical with scammonin. The chief constituent of true jalap is about 10 per cent. or more of resin; other constituents of the drug are starch, gum, sugar, colouring matter, calcium oxalate, and a very small amount of volatile oil. The starch is frequently gelatinised by the heat employed to dry the roots, and thus gives the drug a horny appearance; the interior of more carefully dried roots presents a mealy appearance. About 90 per cent. of the resin is soluble in alcohol, but insoluble in ether, and to this portion the names jalapin and convolvulin have been applied; the remaining 10 per cent. of the resin is soluble in both alcohol and ether, and appears to be identical with scammony resin. Much confusion exists in text-books and works of reference with regard to the names of the two resins, but the name "jalapin" should be restricted to that which is present in the greater proportion in the drug and distinguished by its insolubility in ether, while the ether-soluble resin may properly be named "scammonin" if it is identical with the ether-soluble resin of scammony. Scammonin also constitutes about 90 per cent. of the resin (tampicin) obtained from Tampico jalap, and is the sole constituent of the ether-soluble resin (orizabin) of Orizaba jalap.

[Dose.—5 to 20 grains.]

## Jalapæ Resina.

**Jalap Resin** is extracted from the dried tubercles of *Ipomœa Purga*, Hayne (N.O. Convolvulaceæ), by exhausting the powdered drug with 90 per cent. alcohol, and subsequently removing the solvent by distillation, distilled water being added to the tincture before distillation in order to facilitate recovery of the whole of the alcohol. The resin is freed from soluble impurities by washing thoroughly with hot distilled water, but when prepared as described it will contain colouring matter and any other constituents of jalap that may be soluble in alcohol but insoluble in water.

**Characters and Tests.**—Jalap resin, prepared by the official process, occurs in dark-brown, opaque, brittle fragments, which are translucent at the edges and break with a resinous fracture. It is readily reduced to a pale-brown powder, which has a peculiar sweetish odour and somewhat acrid taste. The powder should dissolve easily in 90 per cent. alcohol, but not in oil of turpentine, and it should yield little or nothing to warm water, thus showing that it has been properly freed from soluble impurities. If scammony resin or the resin of Tampico jalap be used to adulterate jalap resin, the powdered drug will yield more than 10 per cent. to ether. The absence of guaiacum resin is indicated by a solution of the drug in 90 per cent. alcohol not being coloured bluish-

green on the addition of test solution of ferric chloride. If common resin (colophony) be present, gelatinisation takes place on cooling the solution obtained by digesting 1 gramme of the drug with 10 C.c. of solution of ammonia for about an hour, at a temperature of 80° C.

**Notes.**—Though sufficiently pure for practical purposes, the official jalap resin contains matter which can be removed by treatment of an alcoholic solution with animal charcoal, a nearly white product being then obtained. This purified resin is entirely soluble in 90 per cent. alcohol, but only yields about 10 per cent. to ether. The portion insoluble in ether is properly named jalapin, but has also been known as convolvulin, rhodeoretin, and jalapurgin; the ether-soluble resin appears to be identical with the resins of scammony (scammonin), male jalap (orizabin), and Tampico jalap (tampicin), and may therefore be distinguished as scammonin, but the name “jalapin” is sometimes incorrectly applied to it. Neither jalapin nor scammonin, however, is a substance of definite composition, and many of the conclusions which have been recorded respecting the composition of jalap resin and various amorphous products obtained therefrom have been shown to be erroneous. By successive extraction with various solvents the resin may be resolved into several products which are amorphous and of indefinite composition. Thus, the ether-soluble resin contains a small amount of a dihydric alcohol named ipurganol, and yields, after treatment with alkalis and dilute sulphuric acid, a phytosterol, cetyl alcohol, volatile acids, and various amorphous products. The resin insoluble in ether contains a small quantity of  $\beta$ -methyl æsculetin, and yields, after treatment with alkalis and dilute sulphuric acid, formic, acetic, butyric, valeric, dextro-methylethylacetic, azelaic, sebacic, convolvulinolic, ipurolic, and other acids, glucose being also produced by this treatment.

[Dose.—2 to 5 grains.

## Kaolinum.

**Kaolin** is a native aluminium silicate, which is used in the form of powder after being freed from gritty particles by elutriation. The mineral occurs in Cornwall in abundant deposits, as a decomposition product of the felspar of granitic rocks, a double silicate of aluminium and alkali, from which, in its weathering, the alkali is gradually eliminated. Pure kaolin has the formula  $\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2, 2\text{H}_2\text{O}$  and contains approximately 47 per cent. of silica, 40 per cent. of alumina, and 13 per cent. of water.

**Characters and Tests.**—Kaolin is a soft whitish powder, which is insoluble in water or in diluted acids. When fused with alkalis—such as potassium or sodium hydroxide or carbonate—it is decomposed, a silicate and aluminate of the alkali metal being formed. The fused mass will dissolve partially when digested in water, and the filtrate, when neutralised with hydrochloric acid, will deposit silica in a hydrated, gelatinous condition. The filtrate, in this case, will contain the aluminium in the form of chloride, with the alkaline chlorine, and yields a gelatinous precipitate of aluminium hydroxide on the addition of solution of ammonia.



**Notes.**—An entirely soluble product can only be obtained from the mass produced on fusing kaolin with alkalies, by sufficiently prolonged fusion at a high temperature. Kaolin is known as china or porcelain clay, being used in making white china and porcelain. Varieties of it are also used as a basis for carbolic and other disinfecting powders, which are known as “silicate” powders, to distinguish them from similar articles made with chalk or limestone. When finely ground and washed, kaolin is also used as an absorbent powder, like fuller’s earth. It is a useful clarifying agent and, as it is not easily affected by most chemical reagents, it serves as a good diluent for phosphorus, silver nitrate, potassium permanganate, gold chloride, or other easily-reduced salts of metals, and is sometimes used as an excipient for pills containing those salts, though a mixture of paraffins, with or without the addition of kaolin, answers better.

## Kino.

**Kino** is the evaporated juice obtained from the trunk of *Pterocarpus Marsupium*, Roxburgh (N.O. Leguminosæ), a lofty tree which grows upon the mountains of the Malabar coast of Hindostan. The bast of the tree contains numerous cells filled with a red astringent liquid which exudes when incisions are made in the bark. After collection, the juice is dried in the sun, and the resulting dark mass readily breaks up into angular pieces of variable size. Though imported in fairly large pieces, it is usually seen in small grains, owing to its extremely brittle nature, which causes the pieces to disintegrate. The drug is known in commerce as East Indian, Malabar, or Madras kino.

**Characters and Tests.**—Kino occurs in small, angular, glistening, opaque fragments, which are remarkably free from dust. They are of a black or reddish-black colour, and thin laminæ appear transparent and ruby-red at the edges. The fragments are hard and brittle, break with a vitreous fracture, and yield a brownish-red powder. They are without odour, but have an astringent taste owing to the presence of a peculiar tannic acid, and contain a colouring matter which tinges the saliva red when the drug is chewed. Kino should be only partially soluble in cold water, more soluble in hot water (from 80 to 90 per cent.), and almost entirely soluble in 90 per cent. alcohol, but it should yield little or nothing to ether. It yields about 1·5 per cent. of ash.

**Notes.**—Various kinds of kino are imported—chiefly from Africa and Australia, though occasionally from the West Indies, South America, etc.—but the distinctive characters of the official kino suffice to check substitution. Its blackish colour and freedom from dust also distinguish it from eucalyptus gum, which is of a ruby or garnet-red colour and has a dusty appearance. The chief constituent of kino is from 70 to 82 per cent. of kinotannic acid; the drug also contains kino-red, 10 to 15 per cent. of moisture, and small quantities of pyrocatechin (catechol), gallic acid, and mineral constituents. Kinotannic acid gives a greenish-black precipitate with ferric salts, and is converted into kino-red when boiled with a dilute mineral acid. The name kinoin has been applied to a colourless, crystalline substance which was said to have been obtained from

kino, but it has been proved that no such substance exists in Malabar kino. Kino-red is a phlobaphene which is deposited when kino is boiled in water and the decoction allowed to cool; a similar deposition takes place when the surface of a cold filtered aqueous solution is long exposed to air. Tincture of kino tends to gelatinise, and gradually loses its astringency on keeping, owing to the conversion of the tannic acid into a body which is insoluble in alcohol. The cause of the change which takes place when gelatinisation occurs is an oxydase or oxidising enzyme, the action of which appears to result in a molecular alteration of the tannic acid. If the kino is heated sufficiently directly after being collected, or if its freshly-prepared solutions are boiled, the enzyme is destroyed, and gelatinisation is then not likely to occur.

[Dose.—5 to 20 grains.

### Krameria Radix.

**Krameria** or **Rhatany Root** is obtained from two species of *Krameria* (N.O. Polygalæ), Para rhatany being supposed to be the product of *K. argentea*, Martius, a native of Brazil, while Peruvian or Payta rhatany is obtained from *Krameria triandra*, Ruiz and Pavon, which grows on the mountain slopes of Peru and Bolivia. Both are shrubs, producing branched, spreading roots, which are dug up after the rains and dried.

**Characters.**—Para rhatany occurs in long, nearly straight, cylindrical pieces, not often exceeding 12 Mm. in thickness, and is characterised by its dark purplish-brown colour and smooth thick bark, which adheres firmly to the pale reddish-brown wood and is marked at intervals by deep transverse cracks and longitudinal wrinkles. A transverse section of the root exhibits a dark purplish-brown bark occupying about one-half the radius of a root of medium size, and a reddish-brown wood, which has a short fracture. Peruvian rhatany root is large and knotty at its upper extremity, but divides near the crown into several long stout branches which sub-divide into smaller branches. The larger pieces have a dark reddish-brown colour; smaller pieces are usually brighter and smoother, and do not exhibit any conspicuous transverse fissures. A transverse section of the root exhibits a comparatively narrow reddish-brown bark, occupying about one-fourth the radius of a root of medium size, and a pale reddish or yellowish wood. The rough and scaly bark is rather fibrous, thinner than that of Para rhatany, and bright reddish-brown internally; it separates readily from the yellowish woody axis. The dense wood breaks with a splintery fracture, contains minute vessels and is marked with numerous narrow medullary rays. Neither Para nor Peruvian rhatany possesses any odour; the bark of both kinds has a strongly astringent taste, owing to the presence of tannin, and contains a reddish colouring matter which tinges the saliva red when the bark is chewed.

**Notes.**—Para rhatany is distinguished by its dark purplish-brown bark, which exhibits deep transverse cracks, while Peruvian rhatany has a reddish-brown bark, which is free from deep transverse cracks and is scaly or smooth according as the pieces of root are large or small. The proportion of bark to wood, as exhibited in transverse sections, is also characteristic in the two kinds, being twice as great in Para as in Peruvian rhatany. A tincture made with

Para rhatany gives a bluish-grey precipitate with lead acetate, but a tincture of Peruvian rhatany gives a red-brown precipitate with that reagent; a tincture of Para rhatany also forms a clearer mixture with water than one made with Peruvian rhatany, which is stated to be richer in substances soluble in alcohol, though it contains less tannin. Para rhatany has been offered as Savanilla rhatany, but Savanilla or New Granada rhatany, properly so called, the product of *K. tomentosa*, does not often come into the market. It resembles Para rather than Peruvian rhatany in its characters, but thin sections of it become violet when moistened with a solution of ferrous sulphate, while those of Para rhatany become bluish-black, and those of Peruvian rhatany become greyish. The root of *K. lanceolata*, Torrey, a North American plant, becomes deep purple when treated with ferrous sulphate. Antilles rhatany, which is not often imported, appears to be identical with the Para variety. Guayaquil rhatany is of unknown origin and but rarely seen on the market; it occurs in large reddish-brown pieces with blackish streaks, is somewhat striated on the surface and dotted over with small warts. The chief constituent of rhatany root is about 8·4 per cent. of krameria-tannic or ratanhia-tannic acid, which resides in the bark. The colouring matter of both roots is krameria-red or ratanhia-red, a dark-red phlobaphene which is produced by the decomposition of tannin. In the presence of fused potassium hydroxide, the tannin is transformed into protocatechuic acid and phloroglucin, whilst with dilute acids it gives glucose and ratanhia-red. Other constituents of rhatany root are gum, starch, etc. Rhatanine or ratanhine, an amido-acid resembling tyrosine, has been obtained from extracts of rhatany, and occurs in spherical groups of white needles.

## Lamellæ.

**Discs or Lamels** are small discs of glycero-gelatin containing some dissolved medicament. They are intended for eye-treatment and are made very thin so that they can be easily inserted between the eye-ball and lid. There are four official lamellæ.

### Lamellæ Atropinæ. DISCS OF ATROPINE.

Each disc contains 1/5000 grain (0·013 milligramme) atropine sulphate.

### Lamellæ Cocainæ. DISCS OF COCAINE.

Each disc contains 1/50 grain (1·3 milligramme) cocaine hydrochloride.

### Lamellæ Homatropinæ. DISCS OF HOMATROPINE.

Each disc contains 1/100 grain (0·65 milligramme) homatropine hydrobromide.

### Lamellæ Physostigminæ. DISCS OF PHYSOSTIGMINE.

Each disc contains 1/1000 grain (0·065 milligramme) physostigmine sulphate.

## Laurocerasi Folia.

**Cherry-Laurel Leaves** are obtained from *Prunus Laurocerasus*, Linné (N.O. Rosaceæ), an evergreen shrub or small tree, which is indigenous to Persia and Asia Minor, but cultivated in Europe and most temperate regions.



Almost all parts of the plant yield hydrocyanic acid, in a greater or less degree, but the fresh leaves alone are official.

**Characters.**—Cherry-laurel leaves are smooth, dark green, and shining on the upper surface, much paler beneath, thick, coriaceous, from 12·5 to 17 Cm. long, and, on an average, about 5 Cm. in breadth. They have short strong petioles, and are oblong or somewhat obovate in outline, tapering towards each end and recurved at the apex. The margins are slightly revolute or recurved, and distinctly but sharply serrate, the serrations being distinctly felt when the finger is passed along the margin of a dried leaf, from apex to base. The midrib is prominent on the under surface, and gives off lateral veins at angles at 45° to 60°, whilst on each side of it, near the base, are one or two brown depressed spots; those depressions are the remains of glands from which the young leaves exude a saccharine substance in the spring. The leaves are almost inodorous when fresh, but when bruised they emit an odour recalling that of bitter almonds; the odour of the dried leaves when crushed and moistened with water, is similar, but less perceptible.

**Notes.**—The chief constituent of cherry-laurel leaves is prulaurasin, which is isomeric with an amygdonitrile glucoside obtained from amygdalin. Its optical activity is stated to differ from amygdalin, but like that body, it is decomposed in the presence of water by emulsin—and enzyme also contained in the leaves—into benzaldehyde, hydrocyanic acid, and glucose. The decomposition which is less rapid than in the case of bitter almonds, does not appear to take place whilst the leaves remain intact, the emulsin being stored in the endodermis of the veins, and so kept apart from the laurocerasin, which is distributed through the parenchyma of the leaf. At the same time, the fact that the leaves yield benzaldehyde in considerable quantity when distilled without water has been held to prove that the oil exists ready formed, to a certain extent, in the fresh leaves. The yield of hydrocyanic acid from the leaves varies with the season, age of the plant, etc., but fresh leaves from healthy plants yield on an average about 0·1 per cent. In the autumn the yield is less than in the spring or early summer, when the leaves are young and especially rich in prulaurasin. Other constituents of the leaves are a bitter principle, tannin, sugar, and gum.

## Limonis Cortex.

**Lemon Peel** is the fresh outer part of the pericarp of the fruit of *Citrus Medica*, Linné, var. *β-limonum*, Hooker filius (N.O. Rutaceæ), a small tree which, like the orange tree, is probably a native of Northern India, and is now cultivated in all countries bordering on the Mediterranean, especially in Sicily, Southern Italy, Spain, Portugal, and the Riviera. The fruit is gathered and exported whilst green. It resembles the orange in development and structure, but it is easily distinguished by its more elongated ovoid shape and pale yellow colour. The lemon is crowned at the apex by a distinct pointed nipple, the pulp has a strongly but agreeable acid taste, and the peel is aromatic and bitter.

**Characters.**—Lemon peel is pale yellow in colour, and more or less rough externally, the roughness of the outer surface being due to the presence of numerous large oil-glands imbedded in the tissue of the epicarp. The inner surface is whitish, owing to the presence of a small amount of the white spongy mesocarp of the fruit. The strong, fragrant odour and warm aromatic taste are due to the volatile oil contained in the glands; the bitter taste is possibly due to the presence of hesperidin.

**Notes.**—When moistened with strong hydrochloric acid, lemon peel retains its colour or assumes a dingy yellowish-brown tint; orange peel similarly treated changes from yellow to a rich, dark green colour. In the citron (*C. Medica*, Risso) the fruit is much larger, with a rougher and thicker yellow rind; the lime (*C. acris*, Miller) is smaller than the lemon, with a smoother and thinner pale-yellow or greenish-yellow rind, and rounded at the extremities. The chief constituent of lemon peel is the volatile oil, of which about 1 kilo. is yielded by 3,000 lemons. The oil contains dextro- and lævo-limonene, with traces of phellandrene and a sesquiterpene, small quantities of citronellal, geranyl acetate, about 5 to 7 per cent. of citral, and other bodies. Lemon peel also contains a crystalline, bitter glucoside, hesperidin, which is decomposed by dilute acids into hesperetin and glucose, while hesperetin can be split up by the action of potassium hydroxide into hesperetic (iso-ferulic) acid and phloroglucin. Hesperidin forms yellow crystals, and appears to exist most largely in the spongy mesocarp, of which as little as possible should be retained on the narrow, thin bands of peel; it is doubtful, therefore, whether hesperidin is strictly entitled to be regarded as the active bitter principle of lemon peel. Alcoholic solution of ferric chloride darkens thin slices of lemon peel, the hesperidin present being acted upon and turning dingy black.

## Linimenta.

**Liniments** are preparations intended for external use, and are applied by the hand, accompanied by friction; or flannel, or other fabric, may be sprinkled with them and closely applied to the skin. They may be alcoholic solutions of various bodies, oily solutions or emulsions, or semi-fluid mixtures with a soapy basis. Alcohol is employed to aid the rubefacient action and promote absorption of the dissolved materials, while oil and soap enable friction to be applied to the required skin-area. There are fifteen official formulæ for liniments; seven are alcoholic liquids and ten contain camphor, which serves the purpose of increasing the local action of those liniments and sometimes enables them to be easily distinguished from similar tinctures or other preparations intended for internal use. The liniments of camphor, chloroform, and turpentine with acetic acid are oily solutions, while those of ammonia, lime, and mercury are emulsions which contain soap formed by the action of the alkalies on the oils.

### **Linimentum Aconiti. LINIMENT OF ACONITE.**

Made by percolating aconite root with alcohol (90 per cent.) so that  $1\frac{1}{2}$  fluid parts (including the dissolved camphor) are obtained from 1 part of the root.

**Linimentum Ammoniaë.** LINIMENT OF AMMONIA.

A mixture of almond and olive oils partly saponified by solution of ammonia. A liniment thus made is said to be less prone to solidify than one made from olive oil alone.

**Linimentum Belladonnaë.** LINIMENT OF BELLADONNA.

Made by diluting liquid extract of belladonna to twice its volume with alcohol containing some dissolved camphor. It contains 0.375 part belladonna alkaloids per 100 fluid parts.

**Linimentum Calcis.** LINIMENT OF LIME.

Consists of olive oil, partly saponified by solution of lime.

**Linimentum Camphoræ.** LINIMENT OF CAMPHOR.

A solution of camphor in olive oil, commonly known as "camphorated oil."

**Linimentum Camphoræ Ammoniatum.** AMMONIATED LINIMENT OF CAMPHOR.

An alcoholic solution of camphor and oil of lavender, to which strong solution of ammonia is added. Also known as Compound Liniment of Camphor.

**Linimentum Chloroformi.** LINIMENT OF CHLOROFORM.

A mixture of chloroform and liniment of camphor.

**Linimentum Crotonis.** LINIMENT OF CROTON OIL.

An alcoholic solution of croton oil and oil of cajeput.

**Linimentum Hydrargyri.** LINIMENT OF MERCURY.

A mixture of mercury ointment and liniment of camphor partly saponified by the addition of strong solution of ammonia.

**Linimentum Opii.** LINIMENT OF OPIUM.

A mixture of equal volumes of tincture of opium and soap liniment.

**Linimentum Potassii Iodidi cum Sapone.** LINIMENT OF POTASSIUM IODIDE WITH SOAP.

A gelatinous creamy product obtained by triturating a solution of curd soap in water and glycerin with potassium iodide. The gelatinous condition is probably caused by the partial precipitation or "salting out" of the soap from the saline solution of potassium iodide. It is scented with oil of lemon.

**Linimentum Saponis.** LINIMENT OF SOAP.

An alcoholic solution of soft soap; camphor, and oil of rosemary.

**Linimentum Sinapis.** LINIMENT OF MUSTARD.

An alcoholic solution of volatile oil of mustard, camphor, and castor oil.

**Linimentum Terebinthinæ.** LINIMENT OF TURPENTINE.

The oil of turpentine contains dissolved camphor, and is emulsified by trituration with soft soap and water.

**Linimentum Terebinthinæ Aceticum.** LINIMENT OF TURPENTINE AND ACETIC ACID.

A mixture of oil of turpentine, glacial acetic acid, and liniment of camphor.



## Linum.

**Linseed** is the product of the flax plant, *Linum usitatissimum*, Linné (N.O. Lineæ), which is supposed to have been derived originally from Egypt, but is now almost universally cultivated in temperate and tropical regions. The fruit is a globular capsule, about the size of a small pea, and contains ten seeds in distinct cells. The seeds are collected when ripe, and dried.

**Characters.**—Linseed consists of small, brown, smooth, nearly flat seeds, which vary in length from about 4 to 6 Mm., and have a glossy appearance, due to the presence of mucilage. They are ovate in outline, rounded at one end and somewhat obliquely pointed at the other, a slight depression—in which the hilum and micropyle are situated—occurring at one side, just below the apex of the seed, which is anatropous. The glossy surface of the seed is seen to be minutely pitted when examined under a lens. Internally the seed is yellowish-white, and a transverse section reveals the presence of two large oily cotyledons, surrounded by a narrow oily endosperm, which is not always distinctly visible. Linseed is practically inodorous, but has a mucilaginous and oily taste.

**Notes.**—The epidermis of the seed-coat of linseed contains about 6 per cent. of mucilage, which is probably a product of the transformation of starch, and can be extracted by soaking the seeds in cold or hot water, the thick viscid fluid which results when the mucilage is extracted with hot water giving a dense precipitate with lead subacetate, while the addition of alcohol to the fluid causes the formation of white flakes. On hydrolysis the mucilage yields the sugars galactose, dextrose, arabinose, and xylose; treated with nitric acid it yields crystals of mucic acid. Linseed also contains in the endosperm and cotyledons from 30 to 40 per cent. of fixed oil, about three-fourths of which can be extracted by pressure. Other constituents of the seeds are about 25 per cent. of proteids, wax, resin, sugar, phosphates, and a minute quantity of a glucoside—linamarin, which differs from amygdalin in not being decomposed by emulsin, though it is decomposed by dilute acids into sugar, hydrocyanic acid, and a volatile body which possesses some of the characters of a ketone. Starch is present in unripe seeds, but it disappears as ripening proceeds, being apparently converted into mucilage.

## Linum Contusum.

**Crushed Linseed** consists of the seeds of *Linum usitatissimum*, Linné (N.O. Lineæ), reduced to coarse powder, without being deprived of any part of their constituents.

**Characters and Tests.**—Crushed linseed should be recently prepared and have a bland odour, free from pungency or rancidity, when mixed with warm water. Certain cruciferous seeds which often occur as impurities in linseed produce a pungent odour, while the oil in crushed linseed which has been kept for some time becomes rancid and affects the odour accordingly

Not less than 30 per cent. of fixed oil should be yielded by crushed linseed when exhausted with carbon bisulphide; this test is intended to guard against adulteration with ground linseed cake, left after extracting the oil from the seeds by pressure. Crushed linseed adulterated with ground linseed cake will also leave more than 5 per cent. of ash when incinerated with free access of air. The presence of added starch or meal from seeds containing starch is indicated on testing for that substance in the usual manner.

**Notes.**—The cake left after extracting the oil from linseed is sometimes termed oil-cake. Linseed meal or ground oil-cake contains not more than one-fourth of the oil originally present in the seeds and is a much finer powder than crushed linseed, without the oily feeling of the latter.

## Liquores.

**Solutions**, using that term in the restricted pharmaceutical sense, consist chiefly of definite chemical substances dissolved in water. Excluding the so-called concentrated solutions, which will be dealt with separately (*vide* *Liquores Concentrati*, page 272), the remaining preparations of this group fall, for the most part, into two classes:—(1) Solutions of powerful remedies, of convenient dilution, in a form readily available for compounding, which obviate the necessity for weighing minute quantities of such substances as strychnine and mercuric chloride. (2) Solutions of substances, which cannot be conveniently kept or prepared, or are unstable, in the pure and undiluted condition. Ammonia, ethyl nitrite, and lead subacetate are typical of this group.

### **Liquor Acidi Chromici.** SOLUTION OF CHROMIC ACID.

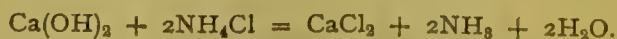
A solution of 1 part chromic anhydride (forming chromic acid) in 3 parts of water.

### **Liquor Ammoniaë.** SOLUTION OF AMMONIA.

An aqueous solution (specific gravity 0.959) containing 10 per cent. ammonia,  $\text{NH}_3$ .

### **Liquor Ammoniaë Fortis.** STRONGER SOLUTION OF AMMONIA.

An aqueous solution containing 32.5 per cent. ammonia,  $\text{NH}_3$ . It is produced by heating a mixture of calcium hydroxide and ammonium chloride, and dissolving the gas, after purification, in distilled water.



The resulting solution is a colourless liquid, with pungent odour, strongly alkaline. Diluted with an equal volume of water and treated with hydrochloric acid in slight excess, no colour or odour should be developed. This test shows that the ammoniacal salt used in its preparation has been properly purified from the tarry substances which are associated with the crude ammonia of the gasworks, the odour of those becoming more apparent when the pungency of the ammonia disappears after neutralisation. The specific gravity is given as 0.891, but a solution of that gravity will only contain about 31.5 per cent.

$\text{NH}_3$ . One gramme requires for neutralisation 19.1 C.c. of normal sulphuric acid solution—

$$\begin{aligned} \text{for 1 C.c. of N/1 H}_2\text{SO}_4 &= 0.01694 \text{ gramme NH}_3 \\ \therefore 19.1 \text{ " " " } &= 0.01694 \times 19.1 \text{ gramme NH}_3 \\ &= 0.324 \text{ gramme NH}_3. \end{aligned}$$

**Liquor Ammonii Acetatis.** SOLUTION OF AMMONIUM ACETATE.

Made by neutralising a solution of ammonium carbonate with acetic acid.

The neutral point cannot be very closely determined by test paper, because of the dissolved carbonic acid. Heating the liquid to expel the dissolved gas is also not of much use, because ammonium acetate is slightly dissociated in aqueous solution; hence, heating the liquid expels ammonia (since this is more volatile than acetic acid), and will leave it acid, even if it be previously neutral. Solutions of ammonium acetate dissolve lead, if any be present, from the glass of the vessels in which they are stored; hence, the direction to store the solution in bottles of green glass, presumably free from lead compounds soluble in this liquid.

[Dose.—2 to 6 fluid drachms.

**Liquor Ammonii Citratis.** SOLUTION OF AMMONIUM CITRATE.

Made by neutralising a solution of citric acid with ammonium carbonate.

Ammonium citrate, like the acetate, should be preserved in green glass bottles.

[Dose.—2 to 6 fluid drachms.

**Liquor Arsenicalis.** ARSENICAL SOLUTION.

This preparation is also known as Liquor Potassæ Arsenitis, or Fowler's solution. It is an alkaline solution containing 1 part of arsenious anhydride in 100 fl. parts, coloured with compound tincture of lavender. The potassium carbonate facilitates solution, and possibly some potassium arsenite is formed. If 25 C.c. be neutralised with hydrochloric acid and diluted with water, it should discharge the colour of 50.8 to 50.9 C.c. of decinormal iodine solution, bicarbonate of sodium being used to neutralise the arsenic and hydriodic acids formed (compare Acidum Arseniosum). The potassium carbonate is neutralised, in the first place, because this normal carbonate reacts with iodine, upon which the bicarbonate has no action under the conditions of the test.

[Dose.—2 to 8 minims.

**Liquor Arsenici Hydrochloricus.** HYDROCHLORIC SOLUTION OF ARSENIC.

A solution in water, acidulated with hydrochloric acid, containing one part arsenious anhydride in 100 fl. parts. The hydrochloric acid increases the solubility of the arsenic indicating that some chemical change takes place although its exact nature is unknown. Arsenic trichloride is decomposed by water into arsenious and hydrochloric acids, so that it does not appear probable that this compound can be formed in the solution. The solution should have the same value as Liquor Arsenicalis in reacting with iodine solution (compare Acidum Arseniosum).

[Dose.—2 to 8 minims.



**Liquor Arsenii et Hydrargyri Iodidi.** SOLUTION OF ARSENIOUS AND MERCURIC IODIDES.

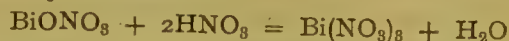
An aqueous solution containing 1 part each of arsenious and mercuric iodides in 100 fl. parts: [Dose.—5 to 20 minims.]

**Liquor Atropinæ Sulphatis.** SOLUTION OF ATROPINE SULPHATE.

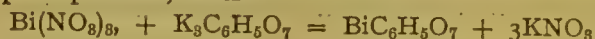
An aqueous solution containing 1 part of atropine sulphate in 100 fl. parts. The water is freshly sterilised by boiling, and a little salicylic acid added to preserve the solution. [Dose.— $\frac{1}{2}$  to 1 minim.]

**Liquor Bismuthi et Ammonii Citratis.** SOLUTION OF BISMUTH AND AMMONIUM CITRATE.

In this preparation, which is also known as Liquor Bismuthi, bismuth oxynitrate is dissolved in fairly strong nitric acid, forming the normal nitrate, and the solution diluted till a faint opalescence appears, indicating the limit to which the acid solution may be diluted without reforming the oxynitrate—



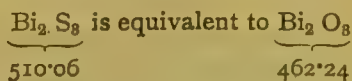
To this solution of nitrate, containing excess of nitric acid, a solution containing potassium citrate and carbonate is added and the mixture boiled. The carbonate neutralises the excess of acid and citrate of bismuth is precipitated, thus—



The precipitate is washed to remove the soluble nitrate, then drained, and solution of ammonia added until it just dissolves. Bismuth hydroxide is formed by the action of the ammonia, thus—



but dissolves in the ammonium citrate solution, forming a complex compound, resembling the scale compounds of iron (compare Ferri et Ammonii Citras). The ordinary salts of bismuth cannot be administered in neutral aqueous solution because water decomposes them, forming insoluble oxysalts. This decomposition can only be prevented by the presence of free acid: hence the complex organic-hydroxy compounds afford the physician the means of giving bismuth in neutral or even alkaline solution. If 10 C.c. of the solution be diluted with 40 C.c. of water it gives with hydrogen sulphide a black precipitate of bismuth sulphide, which, when washed and dried should weigh at least 0.55 gramme.



and

$$510.06 : 462.24 :: 0.55 : 0.50$$

The quantity of sulphide obtained corresponds to about 0.5 gramme of  $\text{Bi}_2\text{O}_3$ , equivalent to 5 grammes per 100 C.c.

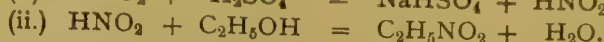
[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Calcis.** SOLUTION OF LIME OR LIME WATER.

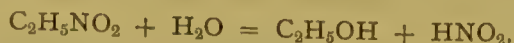
A solution obtained by shaking washed slaked lime with distilled water and allowing the excess to subside. The preliminary washing of the lime is necessary in order to remove chlorides and other soluble salts.



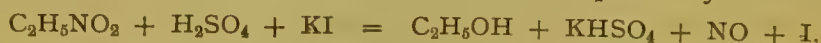
calculated from its specific gravity—is added to the necessary quantity of the solvent mixture of alcohol and glycerin.



Ethyl nitrite in contact with water, or alcohol containing water, undergoes hydrolysis.



hence the selection of a solvent as free as possible from water in making the liquor. Owing to the low boiling point of ethyl nitrite the liquor should be kept as cool as possible and in small bottles to avoid the loss which results each time the containing vessel is opened. If the solution be poured on an acidulated strong solution of ferrous sulphate, a deep-brown coloration is produced at the surface of contact of the two fluids, due to the liberation of nitric oxide (from the nitrite) and the combination of this with ferrous sulphate to form a brown compound. The nitrite is reduced to nitric oxide by a part of the ferrous sulphate which is thereby oxidised to ferric sulphate. The solution should not effervesce with sodium bicarbonate, thus showing the absence of acid which is produced by hydrolysis of the ethyl nitrite. When tested in the nitrometer (*vide* Spiritus Ætheris Nitrosi) it should yield 7·6 volumes of nitric oxide, and even when kept, not less than five-sixths of that volume. From the following equation the statements concerning the proportion of ethyl nitrite contained in the liquor may be verified:—



The equation shows that 22·32 litres of nitric oxide measured at 0° C. and 760 Mm. pressure, will be obtained from 74·52 grammes of ethyl nitrite. The official requirements are that each C.c. of liquor, weighing 0·824 gramme (about), shall yield, when fresh, 7·6 C.c. of nitric oxide at 15·5° C. and 760 Mm. pressure. [*Dose*.—20 to 60 minims.

### Liquor Ferri Acetatis. SOLUTION OF FERRIC ACETATE.

A solution of ferric acetate, obtained by dissolving the freshly precipitated hydroxide in glacial acetic acid and diluting the solution. In preparing ferric hydroxide for this liquor, as well as for any other purpose—the scale compounds, for example—note carefully that the best method of procedure is to pour the solution of ferric salt into excess of ammonia. If the order of mixing be reversed, the precipitated hydroxide will be contaminated with oxy-salt—oxy-sulphate in the present instance. The ferric hydroxide which is produced by the first addition of ammonia to ferric solutions being precipitated in presence of still undecomposed soluble ferric salt, combines with and carries some of this down with it, and retains it even if excess of ammonia be added.

[*Dose*.—5 to 15 minims.

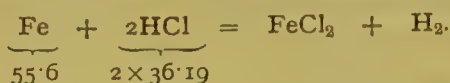
### Liquor Ferri Perchloridi. SOLUTION OF FERRIC CHLORIDE.

Made by diluting one volume of the strong solution of ferric chloride to four volumes with distilled water. [*Dose*.—5 to 15 minims.



**Liquor Ferri Perchloridi Fortis.** STRONG SOLUTION OF FERRIC CHLORIDE.

This is prepared by dissolving iron in excess of hydrochloric acid and oxidising the ferrous chloride, so produced, to ferric chloride by pouring the solution into nitric acid. Ferrous chloride is first produced—



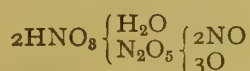
55.6 parts of iron require 72.38 parts of real hydrochloric acid for the formation of ferrous chloride. The four ounces of iron in the

Pharmacopœia formula would therefore require  $\frac{72.38 \times 4}{55.6}$  oz. of real

HCl, or a little over five ounces. Now, 20.5 fluid ounces of strong hydrochloric acid (specific gravity 1.16, and containing 31.79 per cent.

by weight of real HCl) will provide  $\frac{20.5 \times 1.16 \times 31.79}{100} = 7.6$  oz. real

HCl. This extra quantity is necessary for the subsequent formation of ferric chloride. The ferrous chloride is oxidised to ferric chloride by means of nitric acid, which is selected as the oxidising agent because the products of its reduction are volatile, and consequently leave no foreign residue in the finished liquor (compare potassium permanganate or chlorate). Nitric oxide is chiefly produced when ferrous salts are oxidised by means of nitric acid, and under these conditions every two molecules of nitric acid yield three available atoms of oxygen.



Each atom of oxygen is capable of raising two molecules of ferrous chloride to ferric chloride,  $2\text{FeCl}_2 + 2\text{HCl} + \text{O} = \text{Fe}_2\text{Cl}_6 + \text{H}_2\text{O}$ , and this is the key to the equation commonly given in text-books—



It is officially stated that 5 C.c. of this solution should yield 1.6 grammes of  $\text{Fe}_2\text{O}_3$ , but a solution having the specific gravity specified in the Pharmacopœia will not give that proportion of ferric oxide.

**Liquor Ferri Pernitratis.** SOLUTION OF FERRIC NITRATE.

This is obtained by dissolving iron in dilute nitric acid. It contains ferric nitrate, and 5 C.c. should yield 0.23 gramme  $\text{Fe}_2\text{O}_3$ .

[Dose.—5 to 15 minims.]

**Liquor Ferri Persulphatis.** SOLUTION OF FERRIC SULPHATE.

This is obtained by oxidising a solution of ferrous sulphate in dilute sulphuric acid to ferric sulphate by means of nitric acid. Five cubic centimetres should yield 1.04 grammes  $\text{Fe}_2\text{O}_3$ .

**Liquor Hamamelidis.** SOLUTION OF HAMAMELIS.

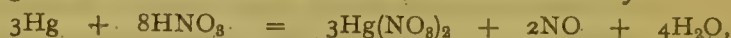
This is obtained by distilling an infusion of fresh hamamelis leaves in weak alcohol (*vide* Hamamelidis Folia).

**Liquor Hydrargyri Nitratis Acidus.** ACID SOLUTION OF MERCURIC NITRATE.

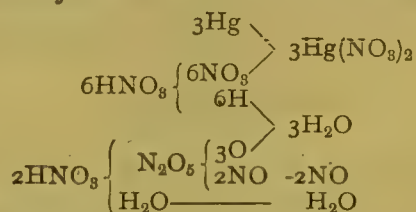
This solution is obtained by dissolving mercury in nitric acid. It contains mercuric nitrate, because excess of nitric acid is employed. If excess of mercury be treated with diluted nitric acid, mercurous nitrate is chiefly obtained. When metals are acted upon by nitric acid, note that the hydrogen, displaced by the metal to form the nitrate, is never evolved—



for nascent hydrogen is a powerful reducing agent, and when produced in presence of an oxidising agent like nitric acid, the latter is reduced and water is formed. Nitric acid is a compound of the highest oxide of nitrogen ( $\text{N}_2\text{O}_5$ , nitric anhydride or pentoxide) and water. When nitric acid is reduced, one or more of the lower oxides are produced, in the present case chiefly nitric oxide, but if the acid be undiluted, chiefly nitric peroxide ( $\text{NO}_2$ ) is evolved. The equation usually given for the action of nitric acid on mercury—



is rendered thus quite simple, for when nitric acid is reduced to nitric oxide, every two molecules of nitric acid yield three atoms of available oxygen. Now three atoms of oxygen require six atoms of hydrogen for the formation of water, and six atoms of hydrogen will be displaced by three dyad mercury atoms—

**Liquor Hydrargyri Perchloridi.** SOLUTION OF MERCURIC CHLORIDE.

This solution contains 1 part of mercuric chloride dissolved in 875 parts of water. It is not, of course, a 1 per cent. solution.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

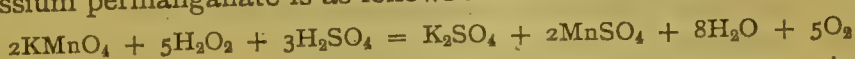
**Liquor Hydrogenii Peroxidi.** SOLUTION OF HYDROGEN PEROXIDE.

A solution of hydrogen peroxide,  $\text{H}_2\text{O}_2$ , in water, obtained by the action of a dilute mineral acid (whose barium salt is insoluble in water) upon barium peroxide,  $\text{BaO}_2$ , suspended in water at a temperature below  $10^\circ \text{C}$ . The barium peroxide is first mixed with water, and shaken at intervals until it becomes hydrated; the dilute mineral acid may be either sulphuric, phosphoric, or hydrofluoric, or carbon dioxide may be passed through the solution to precipitate the barium as carbonate. With sulphuric acid—

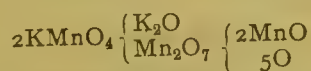


For the stability of the solution, it is necessary to have a slight excess of acid. A few drops of the solution diluted with 10 C.c. of

water should give, with 1 drop of potassium chromate, 10 drops of diluted sulphuric acid, and 2 or 3 C.c. of ether, a blue colour due to the formation of perchromic acid; on agitation, the ether extracts the perchromic acid from the aqueous layer, and acquires a blue colour (Compare tests for *Æther Purificatus*). Treated with diluted sulphuric acid and solution of potassium permanganate in a brine-charged nitrometer, it should yield 18 to 22 times its own volume of oxygen gas, measured at normal temperature and pressure. Salt solution is used in the nitrometer in place of water, since it is denser than water, and the reaction mixture, being specifically lighter, will float on it, and not become diluted too far by admixture. The reaction between hydrogen peroxide and an acidulated solution of potassium permanganate is as follows:—



Note that when permanganate is used as an oxidising agent in acid solution, the manganese is found as a salt corresponding to the oxide  $\text{MnO}$  (e.g.,  $\text{MnSO}_4$ ), while the permanganate may be regarded as derived from the oxide  $\text{Mn}_2\text{O}_7$  (permanganic anhydride). From this it follows that every 2 molecules of permanganate yield 5 atoms of oxygen:—



It should also be carefully noted that one-half the oxygen evolved is derived from the permanganate, hence the commercial products known as 5, 10, or 20 volume solutions should yield, when tested in this way and under the conditions described, twice the volume of oxygen indicated by their trade name. It is stated that the official assay process for solution of hydrogen peroxide gives results which are too high, chlorine being liberated from the salt solution; in order to overcome this difficulty, the use of a saturated solution of magnesium sulphate, instead of brine, has been suggested.

[Dose.— $\frac{1}{2}$  to 2 fluid drachms.]

#### **Liquor Iodi Fortis.** STRONG SOLUTION or LINIMENT OF IODINE.

An alcoholic solution of iodine and potassium iodide. It contains about 1 in  $8\frac{1}{2}$  of iodine.

#### **Liquor Magnesii Carbonatis.** SOLUTION OF MAGNESIUM CARBONATE or FLUID MAGNESIA.

A solution of magnesium carbonate or bicarbonate obtained by suspending freshly precipitated carbonate (oxycarbonate) in water, and passing into the liquid carbonic anhydride under pressure. The carbonate is insoluble in water, but in presence of excess of carbonic acid forms the very unstable bicarbonate. It is directed that the carbonate should be freshly prepared, because the dried carbonate does not so readily dissolve in carbonic acid water. This is a phenomenon very generally met with in chemical operations, *i.e.*, substances precipitated from solutions undergo some kind of aggregation when dried, and become



less readily soluble in substances capable of dissolving them easily in the moist, freshly precipitated condition. Twenty cubic centimetres evaporated to dryness should afford a white residue of hydrated magnesium carbonate, which, after being calcined, leaves between 0.16 and 0.19 gramme of magnesium oxide.

[Dose.—1 to 2 fluid ounces.

**Liquor Morphinæ Acetatis.** SOLUTION OF MORPHINE ACETATE.

This solution contains 1 part of morphine acetate in 100 parts by volume, dissolved in dilute alcohol and a small proportion of acetic acid, to prevent the dissociation of the morphine acetate.

[Dose.—10 to 60 minims.

**Liquor Morphinæ Hydrochloridi.** SOLUTION OF MORPHINE HYDROCHLORIDE. Synonym.—Solution of Hydrochlorate of Morphine.

This solution contains 1 part morphine hydrochloride in 100 parts by volume, dissolved in dilute alcohol and a small quantity of hydrochloric acid. The free acid is not so necessary in this case as it is with the acetate.

[Dose.—10 to 60 minims.

**Liquor Morphinæ Tartratis.** SOLUTION OF MORPHINE TARTRATE.

This is an aqueous solution, containing 1 part morphine tartrate in 100 parts by volume.

[Dose.—10 to 60 minims.

**Liquor Pancreatis.** PANCREATIC SOLUTION.

This is obtained from the fresh pancreas of the pig. The pancreas is disintegrated by trituration with sand, and macerated in weak alcohol (20 per cent.) for seven days. The filtrate will contain the digestive principles. The pancreas contains probably several distinct ferments. Pancreatic extracts possess a three-fold action: they convert starch into sugar, saponify fats, and digest proteids. Although ferments, like other proteid substances, are insoluble in strong alcohol, the *weak* alcoholic menstruum adopted in the Pharmacopœia is capable of yielding an active product. The proportion of alcohol present acts as an antiseptic, and the preparation keeps well if made and stored carefully. The pancreas is sometimes called "sweetbread" but, in obtaining it from the slaughter-house, care should be taken lest there be confusion of terms. The "sweetbread" which is eaten as a table delicacy is the organ known to anatomists as the "thymus," and the butcher distinguishes that as the throat-sweetbread, or more shortly as throat-bread, while the pancreas is called the body-sweetbread. Owing to its tough and stringy nature, the pancreas is of inferior value to the thymus as a food substance. Its disintegration in making the liquor is assisted by adding gritty substances. The distinguishing feature of pancreatic as compared to peptic digestion is the reaction of the digestion fluid, pancreatic requiring an alkaline medium, while peptic digestion is only manifested in an acid medium. This property of pancreatin makes it valuable as a digestive agent for milk, which cannot well be peptonised in acid medium on account of the coagulation which ensues when milk is acidulated.

If 2 C.c. of the solution, with 0.2 gramme of sodium bicarbonate and 20 C.c. of water, be added to 80 C.c. of milk, and the mixture be kept at a temperature of 45° C. for one hour, coagulation should no longer occur on the addition of nitric acid. Absence of coagulation under these conditions indicates that the pancreatic solution has peptonised the milk proteids (which are coagulated when acid is added to fresh milk), *i.e.*, has converted them into peptones (chiefly) which are not precipitated by the addition of nitric acid.

**Liquor Picis Carbonis.** SOLUTION OF COAL TAR.

Prepared by making a tincture of quillaia bark, digesting prepared coal tar with it at a temperature of 49° C. for two days, and decanting the clear liquid. The alcohol extracts from coal tar many of the numerous aromatic antiseptic bodies contained therein, naphthalin being probably the most important. These are mostly insoluble in water, and are precipitated when the alcoholic solution is diluted with water. The saponin which is extracted from the quillaia bark does not prevent the precipitation, but ensures that the precipitated substances shall be finely emulsified. Liquor Picis Carbonis forms a milky fluid when diluted with water, and in this diluted form is used as a lotion.

**Liquor Plumbi Subacetatis Dilutus.** DILUTED SOLUTION OF LEAD SUBACETATE, GOULARD'S LOTION, or GOULARD WATER.

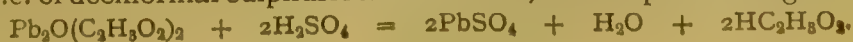
A dilution of the strong liquor with distilled water containing a very small proportion of alcohol. The water used for dilution is directed to be freshly boiled and cooled, in order that it may not contain any carbonic acid, which precipitates a portion of the lead as carbonate. The object of the addition of alcohol is not apparent: the proportion is not high enough to have any cooling effect when the dilute solution is used as a lotion, but it is sometimes stated that the addition is made with the object of expelling dissolved carbon dioxide from the water. This, however, it cannot do, for carbon dioxide is more soluble in alcohol than water.

**Liquor Plumbi Subacetatis Fortis.** STRONG SOLUTION OF LEAD SUBACETATE, or GOULARD'S EXTRACT.

Prepared by boiling lead oxide and acetate with water, so as to obtain a solution of lead oxyacetate. The proportions in the official formula correspond closely with the molecular weights of the two lead compounds.



and should give the oxyacetate  $\text{Pb}_2\text{O}(\text{C}_2\text{H}_3\text{O}_2)_2$ . The acetate and oxide should be free from lead carbonate, which is not capable of yielding the oxyacetate. The solution gelatinises mucilage of acacia. Its specific gravity is 1.275. Each gramme should require for complete precipitation 17 C.c. of decinormal sulphuric acid solution, lead sulphate being formed—



**Liquor Potassæ.** SOLUTION OF POTASH.

An aqueous solution containing 5·85 per cent. of potassium hydroxide. Its strength is determined by titration with normal sulphuric acid solution (*vide* Potassa Caustica). [Dose.—10 to 30 minims.

**Liquor Potassii Permanganatis.** SOLUTION OF POTASSIUM PERMANGANATE.

An aqueous solution of 1 of the salt in 100 by volume.

[Dose.—2 to 4 fluid drachms.

**Liquor Sodæ Chlorinatæ.** SOLUTION OF CHLORINATED SODA.

A solution made by triturating chlorinated lime with distilled water, adding an aqueous solution of sodium carbonate, and filtering the mixed liquids. Three and a half grammes, treated as described under "*Calx Chlorinata*," should require not less than 25 C.c. of decinormal sodium thiosulphate solution, equivalent to about 2·5 per cent. of available chlorine. [Dose.—10 to 20 minims.

**Liquor Sodii Arsenatis.** SOLUTION OF SODIUM ARSENATE.

An aqueous solution containing sodium arsenate equivalent to 1 part of anhydrous salt,  $\text{Na}_2\text{HAsO}_4$ , in 100 parts by volume. The anhydrous salt is directed to be employed because of the variable amount of water in the crystallised salt. Crystallised from cold solutions, sodium arsenate contains twelve molecules of water of crystallisation; from hot solutions a salt having the composition  $\text{Na}_2\text{HAsO}_4 \cdot 7\text{H}_2\text{O}$  is obtained. The former salt effloresces under ordinary conditions, and passes gradually into the latter—

100 grammes of  $\text{Na}_2\text{HAsO}_4 \cdot 12\text{H}_2\text{O}$  contain 46·3 grammes anhydrous  $\text{Na}_2\text{HAsO}_4$ .

100 grammes of  $\text{Na}_2\text{HAsO}_4 \cdot 7\text{H}_2\text{O}$  contain 59·6 grammes anhydrous  $\text{Na}_2\text{HAsO}_4$ .

There is, therefore, considerable room for variation in the actual amount of arsenic present in the liquor, if it be made from the crystals; this is avoided by using the anhydrous salt.

[Dose.—2 to 8 minims.

**Liquor Sodii Ethylatis.** SOLUTION OF SODIUM ETHYLATE.

This is prepared by the action of metallic sodium upon absolute alcohol, and contains about 18 per cent. of sodium ethylate. Metallic sodium displaces the hydrogen from the hydroxyl group of the alcohol—



When the solution is evaporated it leaves a white residue of sodium ethylate. This, when treated with water, forms sodium hydroxide (caustic soda) and alcohol—



This reaction explains why absolute alcohol is employed in making the "liquor," and not rectified spirit. Since the latter contains about 16 per cent. of water, no sodium ethylate would be formed until the water had reacted with the sodium to form sodium hydroxide. Such a preparation would be merely an alcoholic solution of caustic soda. Note the difference in the behaviour of the hydroxylic hydrogen of alcohols and acids. Ethyl alcohol,  $\text{CH}_3\text{CH}_2(\text{OH})$ , and acetic acid,  $\text{CH}_3\text{CO}(\text{OH})$  for example, both contain a hydroxyl group, but the



hydrogen in the hydroxyl of the alcohol is only replaced with some difficulty by metals, while in the case of acids it is replaced easily by metals, forming stable salts. This difference in behaviour is caused by the association of the "acid" hydroxyl with the electro-negative group carbonyl (CO). Compare also phenol,  $C_6H_5(OH)$ , which exhibits weak acid properties (*i.e.*, which contains replaceable hydrogen) with picric acid, tri-nitro-phenol  $C_6H_2(NO_2)_3(OH)$ . The entrance of the three electro-negative ( $NO_2$ ) groups in tri-nitro-phenol causes this body to behave like a strong acid on account of the influence they exert upon the behaviour of the neighbouring hydroxyl group.

**Liquor Strychninæ Hydrochloridi.** SOLUTION OF STRYCHNINE HYDROCHLORIDE.

A solution in dilute alcohol, containing 1 part strychnine hydrochloride in 100 parts by volume. [Dose.—2 to 8 minims.

**Liquor Thyroidei.** THYROID SOLUTION.

A liquor obtained by macerating fresh thyroid glands of the sheep, after slicing and bruising them, with a menstruum composed of equal parts of glycerin and distilled water containing 0.5 per cent. phenol. After maceration the mixture is strained, expressed, and to the product sufficient of the menstruum is added so that 6 C.c. represent one complete gland. In preparing this the utmost cleanliness is required to obtain a liquor which will keep sweet. The proportions of glycerin and phenol in the official menstruum are too small to prevent the development of putrefactive organisms in the solution, on account of the large proportion of water present in the glands. The thyroid is composed of two dark plum-coloured lobes lying close to the trachea, one on each side. In excising them it is usually more convenient to remove the lobes separately, hence the necessity for the reference in the official directions—"for each entire gland (consisting of two lobes)." The thyroid must not be confused with the thymus (*vide* Liquor Pancreatis). When making the liquor the hands of the operator should be well scrubbed with a liberal supply of soap, and the utensils employed may be cleansed by well rinsing them with freshly boiled water, or sterilised by immersion for a few minutes in boiling water, afterwards allowing them to cool just before they are required.

[Dose.—5 to 15 minims.

**Liquor Trinitrini.** SOLUTION OF TRINITRIN OR NITROGLYCERIN.

A solution in strong alcohol of nitroglycerin, containing 1 part in 100 parts by volume. When mixed with an equal volume of water the product remains clear, but the further addition of water should produce an opalescence due to the precipitation of the nitroglycerin which is sparingly soluble in water. If the solution be deficient in nitroglycerin it will remain clear when diluted beyond the extent indicated,

[Dose.— $\frac{1}{2}$  to 2 minims.

**Liquor Zinci Chloridi.** SOLUTION OF ZINC CHLORIDE.

A concentrated solution of zinc chloride obtained by dissolving the metal in hydrochloric acid. If the resulting solution be found to contain iron

or lead, solution of chlorine is added in slight excess and then zinc carbonate, the resulting precipitate is filtered out and the filtrate concentrated. If any iron be present in the granulated zinc, ferrous chloride will be found in the solution. By the addition of hydroxides or carbonates, iron in the ferrous condition is only incompletely precipitated. When a complete separation of iron from a solution is desired, it is always converted into the ferric state, usually by means of nitric acid; but in the present case, since only a small quantity is present, chlorine water is more conveniently used. Instead of adding now the usual reagent—ammonia—for precipitating ferric hydroxide, zinc carbonate is added. Ammonia would leave in solution a corresponding amount of ammonium chloride, thus rendering the solution impure, while zinc carbonate by double decomposition yields more zinc chloride. The iron is precipitated as ferric hydroxide, because ferric carbonate is unstable, and decomposes in presence of water, forming ferric hydroxide, carbon dioxide being evolved.

### LIQUORES CONCENTRATI.

Ten of the official "liquors" are prepared from vegetable drugs, and are intended to provide uniform preparations to replace the so-called concentrated infusions and decoctions found in trade. In the absence of official formulæ, those last mentioned products have hitherto been prepared by each manufacturer according to his own formulæ, and the resulting preparations obtained from different sources have been found to be very variable in physical characters and potency. As a remedy for that undesirable state of affairs, and in deference to the demand which undoubtedly exists for preparations of this nature, the official formulæ have been introduced. The name "concentrated solution," as applied to them, is open to criticism, since the official solutions have hitherto included (with the exception of *Liquor Epispasticus*) only solutions of definite chemical substances, and not complex and variable fluids obtained by the selective solvent action of menstrua upon crude vegetable drugs. Unofficially, however, the extension of the term to include such vegetable preparations has been recognised, and it is difficult to see into which other of the existing official classes of galenical preparations they could have been introduced. The term concentrated infusion is not applicable, because preparations obtained by actually concentrating the official infusions are lacking in the aroma and other distinctive physical characters associated with preparations of this class. For that reason quite different processes have been adopted for the new concentrated liquors—in most cases slow percolation with dilute alcohol which has a similar selective solvent action to water upon the constituents of vegetable drugs, and is at the same time sufficiently strong in alcohol to have the necessary preservative action. Another course open to the compilers of the *Pharmacopœia* would have been to coin a new title for them, but apparently that has not been deemed desirable. The drugs are used in No. 40 powder, with the exception of *calumba*, *rhubarb*, and *senna*, which are in No. 5 powder, and the constituents of the *sarsaparilla* preparation. In all cases except the

last-mentioned, cold processes are employed, hence it is desirable to facilitate the exhaustion by using a powder as fine as is practicable. The three drugs mentioned as being used in No. 5 powder yield thick mucilaginous fluids with water or weak alcoholic menstrua when used in finer powder, and those are percolated and filtered with extreme difficulty. The practicability of several of the official formulæ is questionable, and some of the products appear to deposit and alter in physical appearance on keeping.

**Liquor Calumbæ Concentratus.** CONCENTRATED SOLUTION OF CALUMBA.

Prepared by two successive macerations with water, followed by expression, alcohol being added as a preservative. Calumba cannot be percolated satisfactorily, owing to the presence of mucilage. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Chiratæ Concentratus.** CONCENTRATED SOLUTION OF CHIRETTA.

Prepared by slowly percolating the powdered drug with 20 per cent. alcohol until 2 parts of percolate have been collected from 1 part by weight of drug. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Cuspariæ Concentratus.** CONCENTRATED SOLUTION OF CUSPARIA.

Prepared like Liquor Chiratæ Concentratus. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Krameriæ Concentratus.** CONCENTRATED SOLUTION OF KRAMERIA.

Prepared like Liquor Chiratæ Concentratus. The addition of 10 per cent. of glycerin is said to prevent loss of extractive by precipitation.

[*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Quassia Concentratus.** CONCENTRATED SOLUTION OF QUASSIA.

Prepared like Liquor Chiratæ Concentratus, but 10 parts of percolate are collected from 1 part by weight of drug, on account of its excessive bitterness. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Rhei Concentratus.** CONCENTRATED SOLUTION OF RHUBARB.

Prepared like Liquor Chiratæ Concentratus. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Sarsæ Compositus Concentratus.** CONCENTRATED COMPOUND SOLUTION OF SARSAPARILLA.

Prepared from the same substances as the old compound decoction, viz.: Sarsaparilla, sassafras root, guaiacum wood, liquorice root, and mezereon bark. The sarsaparilla is infused and the other constituents are boiled with water. The infusion and decoction are concentrated by evaporation, then mixed and preserved by addition of alcohol.

[*Dose.*—2 to 8 fluid drachms.]

**Liquor Senegæ Concentratus.** CONCENTRATED SOLUTION OF SENEGA.

Prepared like Liquor Chiratæ Concentratus, but with slightly stronger alcohol (about 28 per cent.). [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Sennæ Concentratus.** CONCENTRATED SOLUTION OF SENNA.

Prepared by repercolation with water, the percolate being heated to about 80° C., to coagulate albumin, and preserved by the addition of alcohol and tincture of ginger. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Liquor Serpentariæ Concentratus.** CONCENTRATED SOLUTION OF SERPENTARY.

Prepared like Liquor Chiratæ Concentratus. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]



## Lithium Carbonates.

**Lithium Carbonate**,  $\text{Li}_2\text{CO}_3$ , is obtained from native silicates, containing lithium, associated with other alkali metals. Spodumene contains about 6 per cent. of lithium oxide, and petolite and lepidolite about 3 per cent. These minerals are fused and boiled with hydrochloric acid, which decomposes them into silica and metallic chlorides. From the mixed solution of those chlorides the lithium is usually separated as carbonate by the addition of sodium carbonate, since it is very much less soluble than the other alkali carbonates particularly in presence of excess of sodium carbonate.

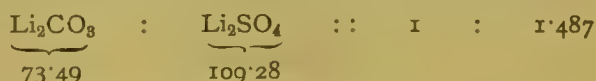
**Characters and Tests.**—Lithium carbonate occurs in white powder, or in minute crystalline grains, soluble in about 70 parts of cold water, insoluble in 90 per cent. alcohol. Its aqueous solution is alkaline to litmus. It is dissolved by hydrochloric acid forming lithium chloride and evolving carbon dioxide, thus—



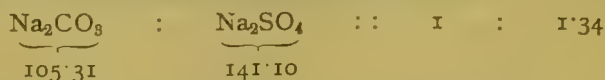
This solution, or the residue obtained by its evaporation, communicates a crimson colour to the flame when introduced on platinum wire, the colour being more intense than that afforded by the carbonate, because the chloride is more volatile. The lithium chloride, obtained as above described, dissolved in water, yields a solution which gives a precipitate of normal lithium phosphate,  $\text{Li}_3\text{PO}_4$ , on the addition of sodium phosphate solution.



One gramme of lithium carbonate neutralised with sulphuric acid and heated to redness should yield not less than 1.479 grammes of lithium sulphate, corresponding to 99.5 per cent. of the pure carbonate (B.P. says 98.5).



This is an indirect test of purity, since the atomic weight of lithium is less than that of any other metal, and the carbonate yields a proportionately larger quantity of sulphate than is yielded by other carbonates. Thus, 1 gramme of  $\text{Na}_2\text{CO}_3$  yields only 1.34 grammes  $\text{Na}_2\text{SO}_4$ , because



Lithium carbonate should be free from lead, copper, arsenium, iron, aluminium, zinc, magnesium, sodium, potassium, ammonium, and chlorides, and contain only traces of calcium and sulphates.

**Notes.**—Lithium occupies a position between the alkali metals (K, Na) and the metals of the alkaline earths (Ca, Ba, Sr). It approaches the latter in the slight solubility of its carbonate and phosphate. This property of those two salts, the solubility of lithium chloro-platinate in water, and of lithium chloride in alcohol and ether-alcohol are utilised to separate lithium from potassium and sodium. It will be noticed that normal lithium phosphate, like calcium phosphate, is stable in the presence of water and is not hydrolysed like the

corresponding sodium salt,  $\text{Na}_3\text{PO}_4$ . Its precipitation by adding solution of sodium phosphate (di-sodium hydrogen phosphate,  $\text{Na}_2\text{HPO}_4$ ) is, therefore, attended by liberation of free acid, as has been shown. Since lithium phosphate is soluble in acids, the test is rendered more delicate by the addition of ammonia or excess of sodium phosphate to neutralise the acid which otherwise may retain the lithium phosphate in solution, if the latter be present in small quantity. [Dose.—2 to 5 grains]

### Lithii Citras.

**Lithium Citrate**  $\text{C}_3\text{H}_4\cdot\text{OH}\cdot(\text{COOLi})_{3,4}\text{H}_2\text{O}$  (or  $\text{Li}_3\text{C}_6\text{H}_5\text{O}_{7,4}\text{H}_2\text{O}$ ) is obtained by neutralising a solution of citric acid with lithium carbonate and crystallising the product.

**Characters and Tests.**—Lithium citrate is a white crystalline deliquescent salt, entirely soluble in twice its weight of cold water. It yields the reactions characteristic of lithium and of citrates. Heated to redness it blackens, evolving inflammable gases; and the black residue, containing lithium carbonate, neutralised with hydrochloric acid, yields with alcohol ( $\text{LiCl}$  is freely soluble in alcohol) a solution which burns with a crimson flame. Dried at  $100^\circ\text{C}$ ., the salt loses three fourths of its water of crystallisation, the remainder being expelled only at  $115^\circ\text{C}$ ., or at  $140^\circ\text{C}$ . according to some authorities, so that 2 grammes of the crystals lose 0.38 gramme in the first case and 0.51 gramme ( $0.38 + 0.13$ ) in the second, for—

$$\begin{array}{rcccl} \text{Li}_3\text{C}_6\text{H}_5\text{O}_{7,4}\text{H}_2\text{O} & : & \text{Li}_3\text{C}_6\text{H}_5\text{O}_{7,4}\text{H}_2\text{O} & :: & 2 & : & 1.62 \\ \text{and} & & & & & & \\ \text{280.05} & & \text{226.41} & & & & \\ \text{Li}_3\text{C}_6\text{H}_5\text{O}_{7,4}\text{H}_2\text{O} & : & \text{Li}_3\text{C}_6\text{H}_5\text{O}_7 & :: & 2 & : & 1.49 \\ \text{280.05} & & \text{208.53} & & & & \end{array}$$

When incinerated at a low red heat, with free access of air, 2 grammes leave a white residue of carbonate which should weigh 0.77 gramme, corresponding to (nearly) 98.5 per cent. of the pure citrate—

$$\begin{array}{rcccl} \text{Li}_3\text{C}_6\text{H}_5\text{O}_{7,4}\text{H}_2\text{O} & : & 1\frac{1}{2} \text{ Li}_2\text{CO}_3 & :: & 2 & : & 0.787 \\ \text{280.05} & & 110.23 & & & & \end{array}$$

It should be free from the impurities mentioned under "Lithii Carbonas."

**Notes.**—If the temperature employed during incineration of the citrate be raised above low redness, some of the carbonate may be converted to oxide by loss of carbonic anhydride and the resulting residue reduced in weight thereby. In order to guard against this, the contents of the crucible after incineration may be moistened with ammonium carbonate solution, cautiously heated to expel water and ammonia, and again weighed. This precaution is more necessary in the quantitative determination of calcium as carbonate, since calcium carbonate is more readily converted into the corresponding oxide than lithium carbonate. [Dose.—5 to 10 grains.]

### Lithii Citras Effervescens.

**Effervescent Lithium Citrate** is obtained by granulating a mixture of lithium citrate, citric and tartaric acids and sodium bicarbonate, the finished product containing about 5 per cent. of the lithium salt. [Dose.—60 to 120 grains.]

## Lobelia.

**Lobelia** is the dried flowering herb of *Lobelia inflata*, Linné (N.O. Lobeliaceæ), an annual or biennial plant, which is indigenous to North America and cultivated for medicinal use in the States of New York and Massachusetts. The plant is collected in August or September, when the fruits are most numerous, and carefully dried. All parts of the plant are of medicinal value, but the roots and inflated capsules are stated to be most powerful.

**Characters.**—Lobelia has angular, channelled stems, which are furnished with narrow wings; they vary from green to yellowish or purplish in colour, and bear one-celled hairs and the scars of alternate leaves. The irregularly toothed leaves are mostly in a fragmentary condition, but they can be recognised by their hairy under-surface. Flowers are seldom present in the drug, but the inflated two-celled capsules are usually so, and, when mature, contain minute brown, oblong, reticulated seeds. A transverse section of the stem exhibits laticiferous vessels in the bast, when examined under the microscope. The somewhat irritating odour of the drug is probably chiefly due to the volatile oil it contains; the burning, acrid taste perceived after chewing the drug resembles that of tobacco, and appears to be due to lobeline. Ash-yield, about 10 per cent.

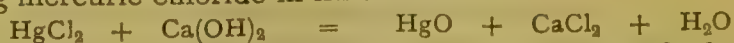
**Notes.**—The distinctive characters of lobelia are the hairy winged stem, inflated fruits, and minute oblong reticulated seeds. It is known as “Indian tobacco” and occurs in commerce either loose or in oblong compressed cakes or packets. It contains the poisonous alkaloid lobeline, a pale yellowish or colourless syrupy liquid which forms crystalline salts. Other constituents recorded are a neutral, crystalline, inactive substance named inflatin, lobelic acid, lobelacrin (probably lobeline lobelate), resin, wax, volatile and fixed oils, gum, and various salts.

## Lotiones.

**Lotions** usually consist of substances dissolved or suspended in aqueous vehicles, often with the addition of glycerin or alcohol. They are usually intended to be applied on lint without friction and differ mainly in this point from liniments. Only two formulæ are official:—

**Lotio Hydrargyri Flava.** YELLOW MERCURIAL LOTION or YELLOW WASH.

Contains yellow mercuric oxide suspended in water and produced by dissolving mercuric chloride in lime water—



Mercuric hydroxide corresponding to the calcium hydroxide is not known; it may be formed as an intermediate stage but decomposes immediately into oxide and water. If the solution of lime be of proper strength the quantity employed in the official formula is almost exactly sufficient for the reaction with the mercuric chloride.

**Lotio Hydrargyri Nigra.** BLACK MERCURIAL LOTION or BLACK WASH.

Contains black mercurous oxide produced by reaction between mercurous



chloride and solution of lime. A little mucilage of tragacanth is added to suspend the black precipitate, and some glycerin to prevent the lint, or other fabric on which it is applied, becoming dry and adhesive.

## Lupulinum.

**Lupulin** consists of the glands obtained from the strobiles of the hop plant, *Humulus Lupulus*, Linné (N.O. Urticaceæ). The glands occur on the bracts, fruits, and, to a less degree, on the stipules of the cone-like collective fruits, being pale greenish-yellow when fresh, though they darken when the hops are kept. They can be separated more or less completely by shaking and beating the ripe strobiles; they also become detached during the collection and drying of hops, commercial lupulin consisting chiefly of the sifted sweepings of the floors of the hop-kilns.

**Characters and Tests.**—Lupulin is usually seen as a granular brownish-yellow powder, with a strong hop-like odour, and bitter, aromatic taste, due to the presence of a volatile oil, resin, and lupamaric acid. It darkens on keeping and acquires an unpleasant odour, owing to the formation of valerianic acid. On examination under the microscope the powder is seen to consist of minute glands, each of which consists of a single hemispherical layer of cells, the cuticle of which has been partly raised, dome-like, by the oily liquid secreted by the gland. When the glands are subjected to pressure a granular oily liquid is discharged. Freedom from sand or other inorganic impurities is indicated by the solubility in ether and the ash yield, the official requirements being that lupulin should not contain more than 40 per cent. of matter insoluble in ether, and not leave more than 12 per cent. of ash when incinerated.

**Notes.**—Commercial lupulin is often mixed with sand, débris of the strobiles, etc., which may be accidentally present or added intentionally. The chief constituent of lupulin is about 3 per cent. of volatile oil (specific gravity, 0.855 to 0.880), which consists chiefly of a sesquiterpene named humulene, together with various oxygenated bodies to which the oil owes its peculiar odour. Other constituents are  $\alpha$ - and  $\beta$ -lupamaric acids, choline, a soft resin which is oxidised to valerianic acid on keeping, wax, and traces of volatile acids. Pure lupulin yields about 80 per cent. of its weight to ether, and may yield only 2.5 per cent. of ash when incinerated. The commercial article, however, does not often yield more than 40 to 70 per cent. of its weight to ether, and may yield from 10 to 25 per cent., or more, of ash. [Dose.—2 to 5 grains.

## Lupulus.

**Hops** consist of the dried strobiles of *Humulus Lupulus*, Linné (N.O. Urticaceæ), a scabrous climbing diœcious plant which grows wild throughout the whole of Europe, and is largely cultivated in England, Germany, Russia, California, etc. The pistillate plant alone is cultivated, and bears cone-like collective fruits, consisting of leafy stipules and bracts which enfold minute fruits at their base. When fully developed the hops are picked, dried in kilns, and frequently exposed to the fumes of burning sulphur, the sulphur dioxide

preserving the colour and probably the odour of the hops ; they are then pressed into compact bales or "pockets."

**Characters.**—Hop strobiles are about 3 Cm. long, oblong-ovoid or rounded in shape, and consist of numerous yellowish-green overlapping (imbricated) membranous stipules and bracts, attached to a hairy axis which has a zigzag course and bears rudimentary branches on alternate sides. Each bract enfolds at its base a small fruit (achene) which is partially surrounded by a perianth. The fruits and the bases of the bracts are sprinkled over with yellowish shining translucent glands (lupulin) which contain the volatile oil to which the aromatic odour and flavour of the drug are due, as well as a bitter principle and tannin, which impart to the drug its bitter, somewhat astringent taste.

**Notes.**—The stipules of hops do not enfold fruits at their bases, and are sprinkled with the glands to a less degree than the bracts and fruits. The volatile oil contained in the glands exists in hops to the extent of 0·3 to 1 per cent. Two crystalline bitter principles— $\alpha$ -lupamaric acid (humulone), and  $\beta$ -lupamaric acid (lupulinic acid)—also occur in the glands, together with choline, wax, and a soft resin which yields valerianic acid by oxidation, whilst the bracts and stipules contain about 5 per cent. of tannin (lupulo-tannic acid), a dark-red phlobaphene, and various salts. The phlobaphene substance is formed from lupulo-tannic acid, and yields hop-red and glucose when boiled with dilute mineral acids. Gallic acid may also be formed from the tannin.

## Magnesia Levis.

**Light Magnesia** or **Magnesium Oxide**,  $\text{MgO}$ , is obtained by exposing light magnesium carbonate to a dull red heat, by which carbon dioxide and water are expelled—



**Characters and Tests.**—Light magnesia is a bulky, white powder differing from heavy magnesia only in its greater lightness, the volumes corresponding to the same weight being to each other in the ratio of three and a-half to one.

**Notes.**—Magnesium oxide is slowly converted into carbonate unless kept in well-closed vessels (see *Magnesia Ponderosa*). Light magnesia is also known as light calcined magnesia.

[*Dose.*—5 to 30 grains (repeated) ; 30 to 60 grains (single).]

## Magnesia Ponderosa.

**Heavy Magnesia** or **Magnesium Oxide**,  $\text{MgO}$ , is prepared by exposing heavy magnesium carbonate to a dull red heat, by which carbon dioxide and water are expelled, as described under *Magnesia Levis*.

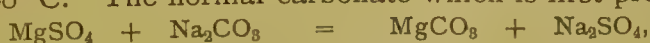
**Characters and Tests.**—Heavy magnesia is a white powder, insoluble in water, but readily dissolved by acids forming the corresponding magnesium salts, the solutions affording the reactions characteristic of magnesium. It should be free from iron, aluminium, calcium, or carbonates, and contain only traces of chlorides and sulphates. When heated to redness it should lose little or no weight, showing absence of carbonate, water and other volatile substances.

**Notes.**—Although practically insoluble in water, magnesia is sufficiently soluble to impart a slight alkaline reaction to the liquid. It slowly absorbs moisture and carbon dioxide from the air, forming carbonate. Heavy magnesia is also known as heavy calcined magnesia.

[*Dose.*—5 to 30 grains (repeated); 30 to 60 grains (single).]

## Magnesii Carbonas Levis.

**Light Magnesium Carbonate**,  $3(\text{MgCO}_3)$ ,  $\text{Mg}(\text{HO})_2$ ,  $4\text{H}_2\text{O}$ , is a basic carbonate, obtained by mixing solutions of magnesium sulphate and sodium carbonate, boiling the mixture, and collecting, washing, and drying the precipitate at  $100^\circ \text{C}$ . The normal carbonate which is first produced—



loses carbon dioxide, and the resulting compound is a hydroxy carbonate.

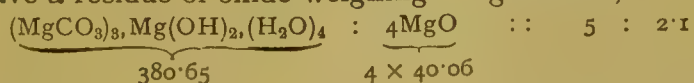
**Characters and Tests.**—Light magnesium carbonate is a very light powder, which, when examined under the microscope, is found to consist of amorphous particles with numerous slender prisms intermixed. The heavy carbonate appears entirely amorphous under the microscope. The other characters and tests are the same as those of heavy magnesium carbonate.

**Notes.**—The composition of light magnesium carbonate may be represented by the formula  $3(\text{MgCO}_3)$ ,  $\text{Mg}(\text{OH})_2$ ,  $4\text{H}_2\text{O}$ , although the proportion of carbonate and hydroxide is liable to some variation with variations in the concentration of solutions, temperature and other conditions under which it may be produced. [*Dose.*—5 to 30 grains (repeated); 30 to 60 grains (single).]

## Magnesii Carbonas Ponderosus.

**Heavy Magnesium Carbonate**,  $3(\text{MgCO}_3)$ ,  $\text{Mg}(\text{HO})_2$ ,  $4\text{H}_2\text{O}$ , is prepared, like the light carbonate, by mixing solutions of magnesium sulphate and sodium carbonate, but the precipitation mixture is evaporated to dryness and the sodium sulphate washed out of the residue by digestion and washing with water. This treatment causes the particles of the precipitate to agglomerate, and the resulting preparation is denser than that obtained by simply collecting, washing and drying the precipitate.

**Characters and Tests.**—Heavy magnesium carbonate is a white granular powder, which dissolves readily, evolving carbon dioxide (distinction from  $\text{MgO}$ ) when treated with dilute mineral acids, and the resulting solutions afford the reactions characteristic of magnesium. Five grammes calcined at a red heat should leave a residue of oxide weighing 2.1 grammes, for—



It should be free from iron, aluminium, and calcium, and contain only traces of chlorides or sulphates.

**Notes.**—The composition of heavy magnesium carbonate may be represented by the same formula as the light carbonate  $(\text{MgCO}_3)_3$ ,  $\text{Mg}(\text{OH})_2$ ,  $(\text{H}_2\text{O})_4$ , provided the dried residue be not overheated, thus causing loss of water and evolution of carbon dioxide.

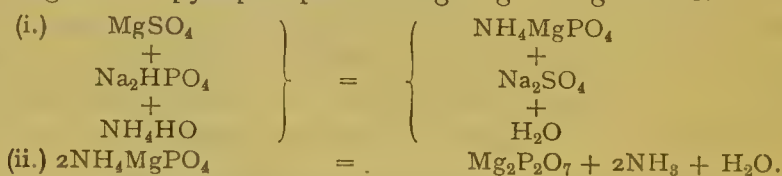
[*Dose.*—5 to 30 grains (repeated); 30 to 60 grains (single).]



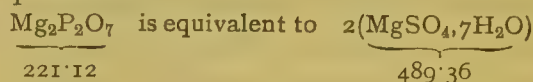
## Magnesii Sulphas.

**Magnesium Sulphate** or Epsom Salt,  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ , may be obtained by the action of sulphuric acid on native magnesium carbonate (magnesite) or on the native double calcium and magnesium carbonate (dolomite). In the latter case the calcium sulphate simultaneously produced is separated by fractional crystallisation, since it is much less soluble than magnesium sulphate. Magnesium sulphate also occurs native, the chief deposit being at Stassfurt, in Germany, where a mineral called kieserite is found having the composition,  $\text{MgSO}_4 \cdot \text{H}_2\text{O}$ . This by recrystallisation from water yields the salt with 7 molecules of water.

**Characters and Tests.**—Magnesium sulphate occurs in small, colourless, transparent, rhombic prisms, soluble in rather more than 1 part of cold water, and possessing a bitter taste. It affords the reactions characteristic of magnesium and of sulphates; 0.5 gramme dissolved in 250 C.c. of water, when set aside for twelve hours with a mixture of solution of ammonia, ammonium chloride and sodium phosphate, yields a crystalline precipitate of ammonium magnesium phosphate, which—when thoroughly washed, dried, and heated to redness—is converted into magnesium pyrophosphate weighing 0.22 gramme.



According to these equations—



and since

$$221.12 : 489.36 :: 0.22 : 0.487$$

the 0.22 gramme of pyrophosphate obtained in the official test corresponds to 0.487 gramme pure  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$  in the 0.5 gramme of Epsom salt taken for analysis, equivalent to 97.4 per cent. purity. Magnesium sulphate should be free from iron, aluminium, zinc, calcium, sodium, potassium, ammonium, and nitrates, and contain only traces of chlorides.

**Notes.**—The precipitate obtained in solutions of magnesium salts, by the addition of solution of ammonia, ammonium chloride, and sodium phosphate, is a very important compound, because it is the form in which magnesium is precipitated in both quantitative and qualitative analysis. In qualitative analysis the precipitate is obtained after the separation of barium, strontium, and calcium as carbonates, by the addition of ammonium carbonate. Although magnesium carbonate is insoluble in water, it is not precipitated with the other carbonates, because of the presence in the solution of ammonium salts, with which magnesium forms double salts which are not precipitated by ammonium carbonate. But to make certain of having sufficient to prevent even a partial precipitation of magnesium, one always previously adds a considerable quantity of ammonium chloride solution. The addition of ammonium hydroxide is also advantageous because it increases the delicacy of the test, the ammonio-mag-

nesium phosphate being slightly soluble in water but practically insoluble in weak ammonia. The production of this precipitate is only diagnostic of magnesium in the absence of barium, strontium, and calcium, since these three metals also form similar insoluble compounds, which are, however, not crystalline like the ammonium magnesium phosphate. To obtain the best results in quantitative analysis the precipitate should be washed with dilute ammonia instead of water, for the reason given above.

[Dose.—30 to 120 grains (repeated);  $\frac{1}{4}$  to  $\frac{1}{2}$  ounce (single).

## Magnesii Sulphas Effervescens.

**Effervescent Magnesium Sulphate**, or effervescent Epsom salt, is obtained by partially removing the water of crystallisation from magnesium sulphate by heating at  $54.4^{\circ}$  C. and mixing the product with tartaric and citric acids, sodium bicarbonate, and powdered refined sugar. The resulting mixture is then granulated by heating and stirring in a pan heated to between  $93^{\circ}$  and  $104^{\circ}$  C. The proportions of the constituents of the granulated and dried product are arranged so that it shall contain the equivalent of half its weight of crystallised Epsom salt.

**Notes.**—The magnesium sulphate is first partly dried so that it may not fuse and liberate its water of crystallisation when mixed and heated with the acids and bicarbonate, as this would bring about effervescence during manufacture.

[Dose.—60 to 240 grains (repeated);  $\frac{1}{2}$  to 1 ounce (single).

## Mel Boracis.

**Borax Honey** is a mixture of 2 parts of borax with 16 of clarified honey and 1 of glycerin.

## Mel Depuratum.

**Clarified Honey** is the saccharine secretion collected from the honeycomb of the bee, *Apis mellifica*, Linné (Order Hymenoptera), purified by melting in a water-bath and then straining, while hot, through flannel previously moistened with warm water. It has not yet been determined by naturalists whether honey is a secretion of the bee or exists already formed in plants. It is probable, however, that the saccharine matter extracted from the nectaries of plants by the bee undergoes some change in the organs of the insect, as it appears to lack some of the characteristic properties of honey. The finest honey is that which is allowed to drain from the comb, and known as “virgin” honey, if obtained from hives which have never swarmed; that obtained by submitting the comb to pressure is inferior, and the product is still more impure if heat be applied before expression. As seen in commerce its consistence varies from that of a viscid liquid like thin syrup or oil to that of lard or soft suet; in colour it is usually white or yellowish, but it may have a brownish or reddish tinge. Its peculiar but agreeable odour varies somewhat, according to the flowers from which the nectar has been collected by the

bees. The sweet, feebly aromatic taste of honey is followed by a slight prickling or sense of acidity in the fauces.

**Characters and Tests.**—Clarified honey, when freshly prepared, is a viscid translucent liquid of a light yellowish or brownish-yellow colour. It gradually becomes opaque on keeping owing to partial crystallisation of the sugar it contains, and is ultimately converted into a soft, granular mass. Its very sweet taste, characteristic but somewhat variable odour, and peculiar flavour, resemble those of crude honey. The clarified liquid should not yield more than 0.25 per cent. of ash when incinerated, a larger proportion indicating the presence of foreign inorganic substances, or possible adulteration with molasses, commercial glucose, etc. On dissolving the ash in water and acidulating the solution with nitric acid, not more than a slight turbidity should be afforded with barium chloride solution, thus indicating the absence of more than traces of sulphates. The presence of sulphates in any appreciable quantity probably indicates adulteration of the honey with commercial glucose, prepared by the hydrolysis of starch with sulphuric acid, and, as the acid is usually neutralised with chalk, the product may then contain calcium sulphate. Starch added to honey to give it a whitish appearance can be detected by the iodine test.

**Notes.**—Crude honey is essentially a strong aqueous solution of mixed dextrose and levulose—"glucose"—containing about 70 to 80 per cent. of the mixture, its specific gravity being about 1.38 to 1.4. It also contains dextrin, wax, proteids, volatile oil, formic acid, colouring matter, and mucilage; pollen, spores, and other flocculent matters are usually present in suspension, and tend to cause fermentation. The faintly acid reaction of honey towards litmus paper is probably owing to the presence of a minute quantity of formic acid, which acts as a preservative. When diluted with water, honey may undergo the vinous fermentation, and, if not very pure, it may ferment in warm weather without being diluted, acquiring a pungent taste and a deeper colour. Inferior honey contains a large proportion of uncrystallisable sugar and vegetable acid. Honey usually exhibits a slight lævo-rotation ( $-2^{\circ}$  to  $-20^{\circ}$ ), and it may yield from 0.3 to 0.8 per cent. of ash which contains only traces of chlorides and sulphates.

## Menthol.

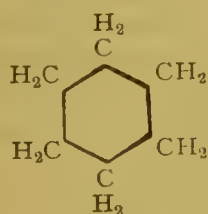
**Menthol** is a crystalline substance which is deposited on cooling oil of peppermint, and sometimes called peppermint camphor. It is chiefly obtained from the oil distilled from the fresh herb of *Mentha arvensis*, De Candolle, vars. *piperascens* et *glabrata*, Holmes (N.O. Labiatae), but may also be obtained from the oil of *M. piperita*, Smith. It is extracted by submitting the oil to fractional crystallisation, or by cooling it to a very low temperature, and removing the adhering oil from the separated crystals by pressure. Most of the menthol which comes into the English market is imported from Japan.

**Characters and Tests.**—Menthol usually occurs in colourless acicular crystals (m.p.  $42^{\circ}$ - $43^{\circ}$  C.), which are more or less moist from adhering oil, but is sometimes, though more rarely, seen in crystalline masses. Its odour and

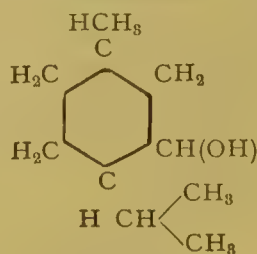


flavour recall those of peppermint, and it imparts to the tongue a sensation of warmth, which is succeeded by a sensation of coolness on drawing air into the mouth. It is almost insoluble in water, but readily soluble (5 in 1) in 90 per cent. alcohol, the solution having a neutral reaction; it is also soluble in chloroform (about 4 in 1), ether (8 in 3), petroleum spirit (10 in 7), and olive oil (1 in 4). Menthol acquires an indigo-blue or ultramarine colour when boiled with sulphuric acid diluted with half its volume of water, the liquid at the same time becoming brown. If thymol be present as an impurity a deep rose colour is developed on heating with sulphuric acid. The presence of thymol may also be indicated by the formation of a green colour on dissolving a few crystals of the impure menthol in 1 C.c. of glacial acetic acid, then adding 3 drops of sulphuric acid and 1 drop of nitric acid. On heating in a water-bath menthol should be entirely volatilised, thus showing the absence of wax, paraffin, spermaceti, or inorganic substances, such as magnesium sulphate.

**Notes.**—The menthol obtained from American peppermint oil is practically identical with the product of Japanese and Chinese oils, but it usually occurs in bolder crystals; it is also present in much smaller proportion in American than Japanese or Chinese oil. Menthol occurs in peppermint oil chiefly in the free state, but partly as menthyl acetate and valerianate. It is a stearoptene, possessing the characters of a saturated secondary alcohol,  $C_{10}H_{19}OH$ , and is closely related to cymene, into which it can readily be converted. It can also be converted by oxidation into a ketone—menthone,  $C_{10}H_{18}O$ —and that, in turn, can be reconverted into menthol by reduction. When distilled with zinc chloride or phosphoric anhydride, menthol yields a peculiar aromatic product, named menthene,  $C_{10}H_{18}$ . Menthol is interesting on account of its behaviour as an alcohol, although it is believed to contain a hydroxyl group, linked to a six-carbon closed chain or nucleus—thus,  $C_6H_5 \cdot OH \cdot CH_3 \cdot C_3H_7$ —and might, therefore, be expected to behave like a phenol. It is, however, regarded as a derivative of hexamethylene,  $C_6H_{12}$ , in which the hydroxyl group has replaced a hydrogen atom in one of the methylene groups: compounds of this nature, belonging to the hexamethylene or “reduced” benzene group, do not exhibit the behaviour characteristic of true aromatic compounds derived from benzene,  $C_6H_6$ . The addition of the six hydrogen atoms or other monovalent atoms or groups has in some way modified the relationship of the six carbon atoms in the hexamethylene ring, so that its derivatives approach in their behaviour to the aliphatic or open-chain compounds. The following formulæ represent what is accepted as the relationship of menthol to hexamethylene—



Hexamethylene.



Menthol.

It will be observed that menthol contains the hydroxyl group replacing a

hydrogen atom in one of the  $\text{CH}_2$  or methylene groups of the hexamethylene ring, which is sometimes described as a "reduced" benzene nucleus, because it contains more hydrogen.

[Dose.— $\frac{1}{2}$  to 2 grains.

## Mezerei Cortex.

**Mezereon Bark** is obtained from *Daphne Mezereum*, Linné (N.O. Thymelacæ), *D. Laureola*, Linné, and *D. Gnidium*, Linné. The first named is widely distributed throughout Europe, including the southern counties of England, but the bark is collected chiefly in Thuringia. The spurge laurel, *D. Laureola*, is a small evergreen shrub, indigenous to Britain; its bark is said to be inferior in medicinal activity, and is seldom collected. The third source of the drug, *D. Gnidium*, is found generally in the countries bordering on the Mediterranean; the bark being largely collected in Algeria and the South of France. In the case of all three species both stem-bark and root-bark are used, being collected in the winter or early spring, when they separate readily in long, flexible strips, which are dried in the form of quills of varying length, or, more usually, made into small bundles or flat disc-like rolls.

**Characters.**—Mezereon bark occurs in long, thin, more or less flattened fibrous strips, or in quills of varying length. It is flexible, very tough, and readily separates into two layers. The outer corky layer of the bark varies in colour from olive-brown or reddish-brown to deep purplish brown. The inner portion of the bark has a pale-yellowish or nearly white, silky inner surface; it is also extremely tough and fibrous, owing to the presence of numerous strands of tough bast fibres, as can be seen in a transverse section. The bark has no marked odour; its persistent acrid, burning taste is due to the presence of a resin.

**Notes.**—The bark of *D. Mezereum* has a very thin, yellowish or olive-brown, transversely wrinkled cork, which is marked, in the case of the stem-bark, with scattered rounded scars of leaves and buds, and often bears the minute black apothecia of small lichens; the cork easily separates from the cortex, which is green in the stem-bark and yellowish in the root-bark. The bark of *D. Laureola* is very similar to that of *D. Mezereum*, but the cork is of a paler brownish colour, and bears elongated, pointed-oval scars of leaves and buds, which are crowded together at intervals. The bark of *D. Gnidium* has a dark purplish-brown cork, with leaf scars resembling those of *D. Mezereum*. The chief constituent of mezereon bark is a greenish-brown, amorphous resin, named mezerein, which possesses extremely acrid and sternutatory properties. It is easily changed into a bitter acid resin, named mezereic acid, which is found in ethereal and alcoholic extracts of the drug. Other constituents of the bark are a crystalline bitter glucoside named daphnin, a fixed oil, and a substance resembling euphorbone, an inactive constituent of euphorbium, or the inert, waxy substance, lactucine or lactucerin, of which lactucarium largely consists. Daphnin—which appears to be identical with coccognin, a principle isolated from the fruits of *D. Mezereum*, and an isomer of æsculin, the glucoside of the horse-chestnut—is converted by acids into sugar and daphnetin or dioxycoumarin, which bears the same relation to pyrogalllic acid that coumarin bears to phenol,

or umbelliferone to resorcin. Umbelliferone has been obtained by the dry distillation of an alcoholic extract of mezereon bark.

## Misturæ.

**Mixtures**, using the word in its limited medical and pharmaceutical sense, are combinations of various drugs in a liquid form, ready for administration to the patient, in doses of about  $\frac{1}{2}$  to 2 fluid ounce. The liquid vehicle is usually water or some aqueous fluid such as an aromatic water, infusion or decoction. The number of possible "mixtures" is therefore almost unlimited, and they are usually prescribed for each patient by the physician according to the special needs of the case. The few official formulæ for preparations of this class include combinations of certain drugs in a particular form and proportion whose employment is indicated by experience and sanctioned by tradition; and to this extent they save the necessity of writing a long prescription with minute directions for manipulation which are necessary in order to secure uniform results. The following are official:—

### **Mistura Ammoniæ.** AMMONIACUM MIXTURE.

Ammoniacum is emulsified by trituration with water and flavoured with syrup of tolu. It is strained through muslin in order to exclude grit and other unavoidable foreign particles in the ammoniacum. Straining through finer material than muslin would exclude the less fine particles of suspended resin from the mixture. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.]

### **Mistura Amygdalæ.** ALMOND MIXTURE.

Compound powder of almonds is triturated with water to form a smooth uniform mixture and strained through muslin to exclude the coarser particles. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.]

### **Mistura Creosoti.** CREOSOTE MIXTURE.

This contains 1 minim of creosote in each ounce (water) flavoured with spirit of juniper and syrup. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.]

### **Mistura Cretæ.** CHALK MIXTURE.

This contains prepared chalk, suspended in cinnamon water by means of tragacanth, and flavoured with sugar. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.]

### **Mistura Ferri Composita.** COMPOUND MIXTURE OF IRON.

This consists of an emulsion of myrrh in rose water, with suspended ferrous carbonate, produced by reaction between ferrous sulphate and potassium carbonate, and flavoured with spirit of nutmeg and sugar. Freshly precipitated ferrous carbonate is stated to be an easily assimilable form of iron, and, at the same time, is free from astringency. The mixture must be freshly prepared, since ferrous carbonate is rapidly oxidised to ferric oxyhydrate, and in this form is not so active; this chemical change is shown by a gradual change of colour from green to reddish-brown. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.]

### **Mistura Guaiaci.** GUAIAECUM MIXTURE.

This contains guaiacum resin finely divided, suspended in cinnamon water by means of tragacanth, and flavoured with sugar.

[Dose.— $\frac{1}{2}$  to 1 fluid ounce.]



**Mistura Olei Ricini.** CASTOR OIL MIXTURE.

An emulsion of castor oil in cinnamon water with mucilage of acacia, flavoured with orange-flower water. [Dose.—1 to 2 fluid ounces.

**Mistura Sennæ Composita.** COMPOUND SENNA MIXTURE OR BLACK DRAUGHT.

A fairly strong solution of magnesium sulphate in infusion of senna, flavoured with liquid extract of liquorice, and preserved by the addition of compound tincture of cardamoms and aromatic spirit of ammonia. The tincture and spirit, in addition to their preservative action, due to the presence of alcohol, act also as carminatives by virtue of the alcohol, ammonia, and aromatic substances they contain, and prevent to some extent the griping pain associated with the action of purgative drugs.

[Dose.—1 to 2 fluid ounces.

**Mistura Spiritus Vini Gallici.** MIXTURE OF BRANDY.

A mixture of brandy, with yolk of egg beaten up with sugar and cinnamon water.

[Dose.—1 to 2 fluid ounces.

## Morphinæ Acetas.

**Morphine Acetate**,  $C_{17}H_{19}NO_3$ ,  $C_2H_4O_2$ ,  $3H_2O$ , is obtained by neutralising morphine with acetic acid, the resulting salt being carefully dried.

**Characters and Tests.**—Morphine acetate occurs as a white, crystalline or amorphous powder, which—when freshly prepared—is almost entirely soluble in 2.5 parts of water, though the addition of acid is usually required in order to effect complete solution, owing to the fact that the salt loses acetic acid when exposed to the air. The salt is also soluble in about 100 parts of 90 per cent. alcohol and in 5 parts of glycerin. It affords the reactions for morphine (*vide* Morphinæ Hydrochloridum) and those characteristic of acetates. Its purity is determined by weighing the morphine precipitated on adding solution of ammonia to a solution of 2 grammes of the salt in morphinated water, the precipitate, which should weigh 1.42 grammes, being washed with the same liquid before being dried and weighed. A little acetic acid is added to the solution of the salt in morphinated water in order to remove a slight turbidity which usually manifests itself. The absence of mineral impurities is shown by the acetate leaving no residue when heated to redness, with free access of air.

**Notes.**—The free alkaloid morphine is distinguished from all common alkaloids by its sparing solubility in ether, chloroform, benzene, or petroleum ether. The only solvent, immiscible with water, in which it is fairly soluble is amylic alcohol, which is usually employed in the separation of small quantities of morphine in toxicological investigations. The purity of each of the official salts is determined by weighing the morphine precipitated by the addition of ammonia to a solution of the salt in morphinated water, *i.e.*, water saturated with morphine by maceration with excess of alkaloid for several days. The morphinated water is employed in place of plain water in order to avoid the loss of alkaloid, which would otherwise result during the operation of washing the precipitate,

owing to the slight solubility of the alkaloid in plain water. It is officially directed that the morphinated water shall be prepared with chloroform water, the presence of the chloroform preventing the decomposition of the weak morphine solution, without, however, perceptibly influencing the solubility of the alkaloid. Morphine acetate loses acetic acid and becomes basic. This basic morphine acetate is not completely soluble in water unless sufficient acetic acid be added to compensate for the acid lost. Old samples of morphine acetate have a brownish colour, and the odour of acetic acid is distinctly perceptible, particularly when the containing vessel is freshly opened. [Dose.— $\frac{1}{8}$  to  $\frac{1}{2}$  grain.]

## Morphinæ Hydrochloridum.

**Morphine Hydrochloride**,  $C_{17}H_{19}NO_8 \cdot HCl \cdot 3H_2O$ , is obtained by neutralising morphine with hydrochloric acid, and allowing the salt to crystallise from the resulting solution.

**Characters and Tests.**—Morphine hydrochloride occurs in acicular prisms with a silky lustre, or as a white powder consisting of minute cubical crystals. It remains unchanged on exposure to air, and does not affect litmus paper. The salt is soluble in 24 parts of cold water, 1 part of boiling water, 8 parts of glycerin, and about 50 parts of 90 per cent. alcohol. The salt affords the reactions characteristic of hydrochlorides and those for morphine. Thus, a white precipitate, which yields mere traces to benzene, is formed on adding solution of ammonia to an aqueous solution of the salt, and this precipitated morphine does not readily dissolve in excess of ammonia, but if solution of potassium hydroxide be employed, the precipitate dissolves readily in excess of that reagent. The absence of other alkaloids is shown by the insolubility of the white precipitate in benzene. An orange-red coloration is produced on moistening morphine salts with nitric acid, and a dull greenish-blue coloration on adding test-solution of ferric chloride, while a violet colour, rapidly changing to blood-red, is produced when a morphine salt is heated on a water-bath for ten to fifteen minutes with a few drops of sulphuric acid, then cooled and treated with a few drops of diluted nitric acid. Morphine salts also dissolve without coloration in strong sulphuric acid, though the addition of a small quantity of sodium arsenate to a portion of the acid solution causes a bluish-green coloration, while the addition of a small quantity of bismuth oxynitrate produces a blackish or purplish-brown coloration. When a solution of 2 grammes of morphine hydrochloride in morphinated water is precipitated with solution of ammonia, it should yield 1.51 grammes of morphine, and the absence of mineral impurities is shown by the salt leaving no residue when heated to redness and burnt with access of air.

**Notes.**—In determining the purity of this and other salts of morphine, great care must be taken in drying the precipitated alkaloid, in order to avoid decomposing it by the application of excessive heat. See also the notes under "Morphinæ Acetas."

[Dose.— $\frac{1}{8}$  to  $\frac{1}{2}$  grain.]

## Morphinæ Tartras.

**Morphine Tartrate** ( $C_{17}H_{19}NO_9$ ) $_2$  $C_4H_6O_6$ ,  $3H_2O$ , may be prepared by the combination of morphine and tartaric acid.

**Characters and Tests.**—Morphine tartrate is a white powder, consisting of fine nodular tufts of minute acicular crystals, which are efflorescent at 20° C. It is soluble in 11 parts of cold water, but almost insoluble in 90 per cent. alcohol. The tartrate affords the reactions characteristic of morphine (*vide* Morphinæ Hydrochloridum) and of tartrates, and 2 grammes of the salt should yield 1.47 grammes of morphine. Freedom from mineral impurities is shown by the absence of residue when the tartrate is heated to redness and burnt with free access of air.

**Notes.**—The solubility of morphine tartrate in cold water has been stated to be 1 in 10 rather than 1 in 11. For explanation of the official test for purity, reference should be made to the notes on the other official salts of morphine. Morphine tartrate is a very useful salt, because it is more soluble in water than the hydrochloride and does not become basic and insoluble like the acetate.

[Dose.— $\frac{1}{8}$  to  $\frac{1}{2}$  grain.]

## Moschus.

**Musk** is the dried secretion from the preputial follicles of the musk deer, *Moschus moschiferus*, Linné (Order Ungulata), an animal which inhabits the vast mountainous regions of Central Asia, extending from India to Siberia, and from China to the Caspian Sea. The male animal alone produces musk, the secretion being found in a small hairy sac situated between the umbilicus and the prepuce. The sac is lined internally by a smooth membrane which is thrown into a number of irregular folds, forming incomplete partitions and thus constituting the preputial follicles. The musk appears to be secreted by the lining membrane as a liquid, but a compact granular mass is gradually formed, which is marked with the folds of the membrane and increases in size with the age of the animal. The outer surface of the sac is covered with hairs and provided with a small opening, whence the secretion is sometimes discharged. After the musk deer have been snared or shot, the sacs or "musk pods" are cut out and dried. In the case of the best musk the pods are wrapped separately in paper, and about twenty-five are packed in a box or "caddy." Most of the musk of European commerce is obtained from China and Thibet; that exported from Shanghai and known as Tonquin or Tonkin musk is the best variety. A small quantity comes from Yunnan, in Southern China, and is known by the name of that province. Musk is also imported from India, being apparently collected in Southern China, Thibet, and the Himalaya district, whence it is sent by way of Nepaul or Assam to Calcutta; some of this Indian musk is imported in grains. Cabardine musk is an inferior kind collected in Thibet and sent thence to China and Japan. Russian musk, procured from Southern Siberia, is said to have a weaker and more fetid odour than the Tonquin variety.

**Characters and Tests.**—Musk forms a soft, moist, granular mass when contained in the sac, but after removal it appears in the form of somewhat



unctuous, dark reddish-brown or reddish-black grains, which have a characteristic, penetrating, persistent odour and a somewhat bitter taste, the latter being due to the presence of a peculiar bitter resin. The pods in which the musk is imported are flattened oval or roundish sacs about 3.5 to 5 Cm. in diameter and from 2 to 2.5 Cm. thick. The pods are smooth and flattened on the side where they have been cut from the animal's skin, but the outer surface is covered with brownish-yellow or greyish, appressed, bristle-like hairs, which are concentrically arranged around a nearly central orifice. The pod has usually been stripped of the outer skin where the flattened surfaces unite, and the thin, soft, supple membrane ("blue skin") which remains appears dark-brown in colour—often with a fine steel-blue iridescence—before the contents of the sac have been removed. Musk should be free from earthy impurities and, on incineration, should yield not more than 8 per cent. of whitish or greyish ash.

**Notes.**—By distillation with steam, musk yields muskone, a viscid, colourless oily ketone which possesses the peculiar odour of musk to a marked degree. The bitter taste appears to be due to the presence of a peculiar bitter resin, whilst fatty matter, cholesterin, ammonia, proteids, various inorganic substances, and about 15 per cent. of moisture are also present. Among the substances which have been found as adulterants of musk are dried blood, which leaves a reddish ash; resin and other substances soluble in spirit, which increase the amount of alcoholic extractive; small stones, shot, scraps of leather or horn, sand, iron filings, hair, animal membrane, etc., etc. From 50 to 75 per cent. of musk should be soluble in water, the solution being deep brown, faintly acid and strongly odorous. Alcohol (90 per cent.) dissolves only 10 to 12 per cent. of the drug, and the resulting light brownish-yellow tincture becomes slightly turbid on the addition of water. Artificial musk (trinitro-butyl-toluene) is prepared by treating tertiary butyl-toluene with a mixture of concentrated nitric and sulphuric acids. It is insoluble in water, but soluble in alcohol. Musk is said to be capable of communicating its odour to three thousand times its weight of inodorous powder. The odour is greatly diminished when musk is mixed with preparations of bitter almonds or with cherry-laurel water, and it is said to be destroyed by rubbing the musk with golden sulphide of antimony or with camphor. The addition of ammonia solution sometimes restores the odour.

[Dose.—5 to 10 grains.]

## Mucilagines.

**Mucilages** are solutions, more or less perfect, of gum in water. Gum is widely distributed as a constituent of vegetable cell-contents, and some varieties form with water only a colloid semi-solution which cannot be filtered bright. There are only two official mucilages.

**Mucilago Acaciæ.**—MUCILAGE OF GUM ACACIA.

A solution of 1 part gum acacia in 1½ parts of distilled water. The gum should be rinsed with water to remove dust and other loosely adherent impurities. This mucilage is the most useful emulsifying agent. It is

usually faintly acid when freshly made, but becomes distinctly acid on keeping, and its emulsifying properties are thereby impaired. The production of acid is probably due to fermentation set up by organisms present in the gum, or which gain access to the mucilage from the air, since the change is prevented to a large extent by keeping the mucilage under aseptic conditions, or by the addition of antiseptics, but accelerated by careless storage and in hot weather.

**Mucilago Tragacanthæ.**—MUCILAGE OF TRAGACANTH.

Produced by diffusing powdered tragacanth in a small quantity of strong alcohol, in which it is insoluble, and then rapidly mixing with the required quantity of water. This method of mixture prevents the formation of clotty lumps, which are produced when the gum is added directly to water, without the intervention of the alcohol. Mucilage of tragacanth is inferior to gum acacia as an emulsifying agent for oils, etc., but preferable, in most cases, for the suspension of insoluble powders, because tragacanth imparts to water much more viscosity than an equal weight of gum acacia.

## Myristica.

**Nutmeg** is the dried seed, divested of its testa, of *Myristica fragrans*, Houttuyn (N.O. Myristicæ), a lofty tree, somewhat resembling an orange tree in appearance, which is indigenous to the Moluccas and neighbouring islands, abounding especially in the Banda islands. It has also been introduced into Penang, Sumatra, Malacca, Java, Singapore, Ceylon, and other parts of the East Indies, as well as Mauritius and Bourbon, Cayenne, and several of the West Indian islands, but the nutmegs of commerce are chiefly, if not entirely, derived from the Malay Archipelago, whence they are exported to Amsterdam and London. The fruit of the tree is a fleshy drupe, the size of a small peach, which turns yellow as ripening proceeds, its fleshy pericarp becoming dry and leathery, then splitting longitudinally, disclosing a scarlet or crimson, lobed and reticulated arillus (mace) surrounding a brown, shining seed. The nutmeg tree yields the crops annually, and the fruit is gathered by hand. After collection the pericarps are removed and the mace is stripped off and dried, its colour changing to reddish-yellow in the process. The seeds are also carefully dried, after which the thin brown shell or testa is removed from each, and the kernels or nutmegs are then sorted, the broken and imperfect ones being reserved for the production of the volatile and expressed oils. The seeds are sometimes dusted or rubbed with slaked lime, or washed with milk of lime, to protect them against the attacks of insects, but Penang nutmegs are distinguished by not being limed.

**Characters.**—Nutmegs are oval, rounded, or broadly and bluntly ovoid in shape, rarely exceed 25 Mm. in length, and are rather less in thickness. They are greyish-brown externally and marked with shallow, reticulated furrows, the surface appearing finely pitted and marked with minute reddish points, larger dark reddish-brown lines, and irregularly elongated spots, on examination with

a powerful lens. Internally, nutmegs are of a waxy consistence and greyish-red in colour, with darker brownish-red veins or lines, so that a transverse section has a marbled appearance. The hilum lies in a little circular depression surrounded by a raised ring, and the course of the raphe can usually be traced in a furrow which extends to the chalaza at the apex of the nutmeg. The embryo is small, and occupies a cavity at the base of the seed. The strong aromatic odour, and aromatic, warm, somewhat bitter taste of nutmegs are due to the volatile and fixed oils they contain.

**Notes.**—The seeds of other species of *Myristica* are distinguished from nutmegs by being longer, narrower, and more or less destitute of aroma. The greater portion of the nutmeg consists of the ruminated albumen, the ruminations being produced by the infolding of part of the perisperm, in the cells of which deposition of dark colouring matter occurs. The infoldings occur near the fibro-vascular bundles, and produce depressed lines on the surface of the nutmeg, which correspond to the branching bundles. The waxy consistence of the seed enables it to be cut easily, and the cut surface readily emits oil when indented with the finger-nail. When distilled with water, nutmegs yield from 8 to 15 per cent. of volatile oil, which consists chiefly of *d*-camphene, with some *d*-pinene, dipentene, geraniol, myristicin, and other bodies, its composition being somewhat variable. Nutmegs also contain about 25 to 40 per cent. of solid fat, three-fourths of which can be extracted by the application of heat and pressure. This expressed oil consists chiefly of myristin or glyceryl myristate, with some myristic acid, palmitin, olein, resin, and volatile oil. It is commonly known as “oil of mace,” and forms yellowish-brown mottled masses, with a very aromatic odour and taste. Other constituents of nutmegs are amyloextrin, albuminoids, mucilage, etc. Mace, or the arillus of the nutmeg, originates in a thickening of the funiculus, which extends to the outer integument of the seed near the exostome; as it develops and surrounds the seed it divides into branching lobes, which approach one another near the apex of the seed. Dried mace contains about 4 to 15 per cent. of volatile oil, of similar composition to the volatile oil of nutmeg; it also yields a fixed oil by pressure. Both oils resemble those of nutmeg in odour, but they are somewhat more fragrant.

## Myrrha.

**Myrrh** is a gum-resin obtained from the stem of *Balsamodendron Myrrha*, Nees (N.O. Burseraceæ), and probably other species, the plants being natives of North-east Africa and Southern Arabia. They contain numerous schizogenous ducts in the bark, and in those an oleo-gum-resin is secreted. The tissue intervening between the ducts frequently breaks down, and lysigenous cavities of considerable size are thus produced and filled with the granular secretion. When fissures form in the bark, in the early autumn after the rains, or when the bark is artificially wounded, the ducts and cavities discharge the secretion as a creamy yellowish-white fluid, which soon hardens to a firm reddish mass and constitutes the myrrh of commerce. There are three chief varieties of myrrh in European commerce—Somali or African



myrrh, collected in Somaliland, N.E. Africa, on the mountains between Zeila and Cape Gardafui; Arabian myrrh, collected in the Fadhli district, to the east of Aden; and Yemen myrrh, collected in the Arabian province of that name. Somali myrrh is thought to be the best, and corresponds to the official description. With regard to Arabian myrrh, it has been stated that there are three varieties in commerce—Arabian myrrh (Hanbury), Arabian myrrh (Dymock), and Yemen myrrh, but the last two are probably identical. In any case, only Somali, Fadhli, and Yemen myrrh—the last two but rarely—are met with in the London market. Somali myrrh occurs in irregularly-rounded, brownish pieces, which are from 25 to 75 Mm. or more in diameter, and covered more or less with fine powder; it is obtained from *Balsamodendron myrrha*, Nees, and is imported into Europe or Bombay by way of Berbera and Aden. Fadhli (Arabian) myrrh, which is also exported from Aden, occurs in smaller and more gummy-looking pieces, which are rarely more than 40 Mm. in diameter, and are not so strongly aromatic as Somali myrrh. Yemen (Arabian) myrrh is more like Somali myrrh, but is of a dark reddish-brown colour, and has a somewhat disagreeable odour; it is probably identical with the Arabian myrrh exported to India (Bombay) from Makalla and Aden.

**Characters and Tests.**—Myrrh occurs in small rounded or irregular fragments or tears, or in masses of agglutinated portions which differ slightly in their shade of colour. The reddish-brown or reddish-yellow pieces vary in size from small grains the size of a pea to masses as large as the fist; the pieces have a somewhat rough, dull, dusty surface, being more or less covered by a fine powder. They are dry and brittle, breaking fairly easily, with an irregular fracture. The fractured surface is somewhat translucent, and of a rich brown or reddish-brown colour; it frequently exhibits opaque, whitish or yellowish spots or veins, and has an unctuous or oily granular appearance. Thin splinters of the gum-resin are translucent or almost transparent. The agreeable aromatic odour and aromatic, somewhat bitter and acrid, taste of the drug are due to the volatile oil and resin which it contains. It may be adulterated with bdellium and other gum-resins which resemble it to some extent, but it is distinguished by the purplish or violet colour it assumes when moistened with nitric acid. A similar coloration is produced when the acid is added to tincture of myrrh. Further, if one part of crushed myrrh be digested with ten parts of ether for a few hours, and the solution filtered into a test tube which is only partially filled, the liquid should assume a violet colour on allowing the vapour of bromine to fill the upper part of the tube; this reaction is due to the volatile oil contained in myrrh. A yellowish emulsion is yielded on triturating powdered myrrh with water. Ash-yield, 4 to 10 per cent.

**Notes.**—It has been incorrectly stated that Yemen myrrh does not give the purplish or violet coloration with nitric acid. Persian myrrh—a variety found in the Bombay market, though of no European importance—does not give that reaction; it is very oily and translucent, of a rich reddish-brown colour, and closely resembles African myrrh in taste, odour and properties. The different varieties of bdellium are either opaque, or their odour and

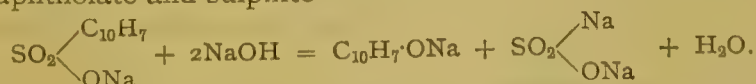
taste distinguish them from myrrh. The constituents of myrrh are from 25 to 35 per cent. of resin, 57 to 61 per cent. of gum, 2.5 to 6.5 per cent. of volatile oil, a bitter principle, and 3 to 4 per cent. of moisture. The volatile oil and the resin are both soluble in alcohol, and the greater portion of the resin—consisting of  $\alpha$ - and  $\beta$ -myrrholic acids—is soluble in ether; the portion insoluble in ether consists of  $\alpha$ -,  $\beta$ -, and  $\gamma$ -commiphoric acids, a combined resin-acid, commiphorinic acid, and two phenolic resins named  $\alpha$ - and  $\beta$ -heerabomyrrholol. The volatile oil (specific gravity, 0.988 to 1.007) is a thick yellowish or greenish fluid of unknown composition, and resinifies rapidly when exposed to the air. The gum, which constitutes the major portion of the drug, resembles acacia gum, contains an oxydase, and makes a good mucilage. The gum-resin, as a whole, is soluble in solutions of the alkalis; hence the reason why potassium carbonate facilitates its suspension in water. Myrrh of good quality should contain not more than 60 per cent. of matter insoluble in alcohol.

## Naphthol.

**Beta-Naphthol**, or  **$\beta$ -mono-hydroxy-naphthalene**,  $C_{10}H_7OH$ , is a derivative of naphthalene, one of the by-products obtained in the manufacture of coal gas. To prepare beta-naphthol, the naphthalene is heated with concentrated sulphuric acid for several hours, at a temperature of  $170^{\circ}$ - $180^{\circ}$  C. At this high temperature beta-naphthalene sulphonic acid is chiefly obtained, while at lower temperature the isomeric alpha-acid is produced in larger proportion—



The product is then diluted and neutralised with calcium hydroxide and filtered. The uncombined sulphuric acid is thus separated as insoluble calcium sulphate from the two isomeric calcium naphthalene sulphonates which are soluble and found, therefore, in the filtrate. This filtrate is evaporated to a pasty consistence, and after standing, strongly expressed. The solid residue will be chiefly beta-calcium naphthalene sulphonate, while the alpha-salt, being much more soluble in water, will be contained in the expressed fluid. The pressed residue, after washing with a little cold water, is then dissolved in hot water and converted into beta-sodium naphthalene sulphonate by treatment with sodium carbonate solution, calcium carbonate being precipitated. The filtrate is concentrated, and the beta-sodium salt crystallised out. This is next added gradually to fused sodium hydroxide at about  $300^{\circ}$  C. The sulphonic group is thus eliminated, with formation of sodium naphtholate and sulphite—

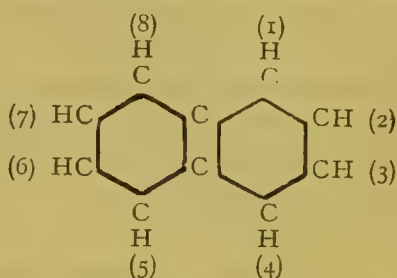


The fused mass is dissolved in water and acidified with hydrochloric acid. This decomposes the sulphite with formation of sulphurous acid, while the soluble naphtholate is converted into the sparingly soluble naphthol, and is hence precipitated, filtered out, and purified by sublimation or recrystallisation—



**Characters and Tests.**—Beta-naphthol occurs in white, or nearly white, crystalline laminæ, or in powder. It has a sharp pungent taste, and an odour resembling phenol. Soluble in about 1000 parts cold water, in 75 parts of boiling water, in less than 2 parts of cold 90 per cent. alcohol, and very soluble in boiling alcohol, ether, or chloroform. It dissolves also in solution of sodium hydroxide, forming (like phenol) the sodium compound—sodium naphtholate,  $C_{10}H_7ONa$ . Melting point,  $122^\circ C$ . On addition of one drop of solution of ammonia to a hot saturated aqueous solution of  $\beta$ -naphthol, a blue fluorescence is developed. A cold saturated aqueous solution gives a white turbidity with solution of chlorine which, on addition of excess of ammonia, gives place to a green or brown coloration, which is due to the formation of a coloured oxidation product of the naphthol under the influence of the chlorine. If 0.1 gramme of  $\beta$ -naphthol be dissolved in 10 C.c. of boiling water, and treated with 10 drops of a 3 per cent. solution of ferric chloride, it gives a white precipitate, which becomes brown and not violet. Ferric chloride oxidises both varieties of naphthol by removing one atom of hydrogen, and the two residues then unite to form isomeric di-naphthols,  $C_{20}H_{12}(OH)_2$ , the beta compound becoming brown while the alpha compound is violet. This test therefore distinguishes the two naphthols.  $\beta$ -naphthol should be neutral to litmus paper moistened with alcohol, showing that it has been purified from the substances used in its preparation, and it should leave no residue of mineral impurities on incineration.

**Notes.**—The  $\alpha$ -naphthol has been stated to be more toxic than  $\beta$ -naphthol, and, though the statement has been contradicted,  $\beta$ -naphthol should always be dispensed unless the other variety is definitely specified. It is a mono-hydroxy derivative of the hydrocarbon naphthalene, which is separated in large quantities from coal tar. The constitution of naphthalene is expressed by the formula—



which shows that it contains two condensed benzene nuclei. The naphthols are consequently very closely related to the phenols, but whereas only one variety of simple phenol—hydroxy-benzene—is possible, owing to the exactly equal value of each of the six CH groups of benzene, two isomeric mono-hydroxy naphthalenes are possible, and both are known. Inspection of the formula shows that replacement of any one of the four hydrogen atoms numbered 1, 4, 5, and 8 by a monovalent group will result in one and the same derivative, owing to the exactly similar relation that each of these hydrogen atoms bears to the remainder of the molecule. On the other hand, replacement of any one of the hydrogen atoms 2, 3, 6, and 7 will lead to the production of another



derivative, different from the previous one, since the first mentioned four atoms of hydrogen are each similarly connected with carbon adjacent to one of the carbon atoms which is common to the two nuclei and not united to hydrogen. In the other four positions the replaceable hydrogen is united to carbon, which is adjacent only to two similar CH groups. The first class includes bodies known as  $\alpha$ -derivatives and the second consists of  $\beta$ -derivatives, one of which is the official beta-naphthol. [Dose.—3 to 10 grains.

## Nux Vomica.

**Nux Vomica** consists of the dried ripe seeds of *Strychnos Nux-vomica*, Linné (N.O. Loganiaceæ), a native of the East Indies, which is found growing in Bengal, Malabar, on the Coromandel Coast, in Ceylon, etc., as well as in Siam, Cochin-China, and Northern Australia. The ripe fruit is one-celled, about the size and colour of an orange, with a smooth, hard, fragile rind, enclosing a whitish juicy bitter pulp, containing from three to five seeds. The pulp is partly derived from the dissepiment between the two cells which exist in the ovary, and has been shown to contain strychnine and loganin. After it has been removed from the seeds by washing, the latter are dried in the sun and exported from Madras, Bombay, and other Indian ports.

**Characters.**—Nux vomica seeds are nearly circular in shape, the discs being flat or slightly convex on one side, concave on the other, and sometimes irregularly bent. They are ash-grey or greenish-grey in colour, from 2 to 2.5 Cm. in diameter and about 6 Mm. in thickness. The edge of each seed is either rounded or somewhat acute, according to the variety, and at one point of the margin there is a small but distinct prominence—the micropyle—from which a ridge or raised line passes to the hilum in the centre of the seed. The ridge does not exist in the fresh seed, and must not be mistaken for the raphe. The hilum may be recognised by the scar left by the funicle. The surface of the seeds has a silky sheen, owing to the presence of numerous short, closely appressed, satiny hairs, which radiate from the centre to the circumference. If one of the dry, hard and horny seeds be soaked in water it softens, and can easily be split into two thinner discs; a small embryo, consisting of a radicle and two leafy cotyledons, can then be seen embedded in the large grey, translucent, horny endosperm. The extremely bitter taste of the seeds is due to the alkaloids they contain; no odour characterises the unbroken seeds, but a faint, sweetish odour distinguishes the yellowish grey powder, being probably due to the fixed oil present.

**Notes.**—The chief constituents of nux vomica seeds are the poisonous crystalline alkaloids, strychnine and brucine, the total alkaloid varying from 1.84 to 5.3 per cent., the average in seeds of good quality being about 2.8 per cent. The two bases are sometimes present in nearly equal proportions, but the ratio of strychnine to brucine may vary as much as 3 to 1 and 1 to 2. Since brucine is much less poisonous than strychnine the amount of total alkaloid affords a somewhat uncertain standard from a medicinal point of view; in the standardisation of preparations of nux vomica, therefore, it is officially directed that the proportion of strychnine shall be determined, as

distinct from total alkaloid. Other constituents of the seeds are a minute proportion of the alkaloid strychnine, a small quantity of the glucoside loganin, igasuric or caffeeo-tannic acid, and about 3 per cent. of fatty and waxy matter, together with gum, starch, proteids, sugar, colouring matter, and a trace of copper. Loganin occurs in much larger proportion in the pulp of *nux vomica* fruit than in the seeds; when it is boiled with dilute sulphuric acid it is resolved into glucose and loganetin.

[Dose.—1 to 4 grains.]

## Olea.

**Fixed Oils, Fats, and Waxes** form a group the members of which have many properties in common, and are conveniently discussed together. As they occur naturally they are composed chiefly of esters of certain of the "fatty acids." Those fatty acids are mostly of high molecular weight, and are homologous either with formic, acrylic, or propiolic acid. For example, stearic acid is homologous with acetic acid, and is therefore a derivative of a member of the saturated series of hydrocarbons. The general formula for the acids of this series is  $C_nH_{2n+1}COOH$ , acetic acid being  $CH_3COOH$ , while stearic acid is  $C_{17}H_{35}COOH$  ( $C_{18}H_{36}O_2$  or  $HC_{18}H_{35}O_2$ ). Other acids of this series are butyric acid,  $C_3H_7COOH$ , one of the characteristic acids of butter, and lauric acid,  $C_{15}H_{31}COOH$ , in coco-nut oil. The fatty acids homologous with acrylic and propiolic acids, on the other hand, are unsaturated; in fact, they bear the same relationship to the saturated acids that the unsaturated hydrocarbons, from which they are derived, bear to the saturated hydrocarbons of the methane series. Thus, the acids of the acrylic series are two atoms of hydrogen, and the members of the propiolic series four atoms of hydrogen poorer than the corresponding acids of the acetic series, just as ethylene,  $C_2H_4$ , and acetylene,  $C_2H_2$ , contain two and four atoms respectively less hydrogen than the corresponding two-carbon hydrocarbon ethane,  $C_2H_6$ , of the saturated series. Acrylic acid, the simplest member of the series so-named, is  $C_2H_3COOH$  (*cf.* propionic acid,  $C_2H_5COOH$ ), and the general formula for the acids of the acrylic series is, therefore,  $C_nH_{2n-1}COOH$ . Oleic acid,  $C_{17}H_{33}COOH$ , is the most important member of this series. Propiolic acid is  $C_2HCOOH$  (*cf.* propionic acid), and the only member of this series of any importance occurring as a constituent of fats is linoleic acid,  $C_{17}H_{31}COOH$ , in linseed oil. The general formula for the acids of the propiolic series is  $C_nH_{2n-3}COOH$ . The fixed oils and fats are composed almost entirely of glyceryl esters of the fatty acids described above, glyceryl,  $C_3H_5$ , being the hydrocarbon residue of the trihydric alcohol glycerin,  $C_3H_5(OH)_3$ . Since the fatty acids are monobasic, the neutral glyceryl esters contain three acid residues combined with  $C_3H_5$ ; for example, glyceryl stearate (stearin) is  $(C_{17}H_{35}COO)_3C_3H_5$ , glyceryl oleate (olein)  $(C_{17}H_{33}COO)_3C_3H_5$ , and glyceryl linoleate (linolein)  $(C_{17}H_{31}COO)_3C_3H_5$ . The fixed oils and fats obtained from natural sources are composed of one or more of those glyceryl esters, and usually a small quantity of free fatty acid, besides traces of albuminous matter, and colouring and flavouring substances to which the special characters of the oils and fats are due. Their exact composition varies within certain limits, depending a good deal upon the methods of prepara-



tion, and the care devoted to purification. Sometimes they contain an undue proportion of free fatty acid, conferring upon them the property known as rancidity. That property is usually due to the fermentative action of bacteria, whose activity is encouraged by careless storage or insufficient care in preparation. The variation in the composition of oils and fats of undoubted purity renders their sophistication comparatively easy and the detection of adulterants correspondingly difficult. The methods of examination will be discussed subsequently. The waxes are composed chiefly of fatty acid esters of monohydric alcohols, mostly of high molecular weight and homologous with methyl alcohol. For instance, spermaceti contains among other compounds the palmitic ester of cetyl alcohol,  $C_{16}H_{33}OH$ , and beeswax the palmitic ester of myricyl alcohol,  $C_{31}H_{63}OH$ . It will be observed that both those alcohols are homologous with methyl alcohol, the general formula for the alcohol of this series being  $C_nH_{2n+1}OH$ . The wax-like substance known as paraffinum durum or paraffin wax is composed almost entirely of a mixture of hydrocarbons of the saturated paraffin series, having high molecular weights, while paraffinum molle is similarly constituted, but the molecular weights of its constituents are lower, and its melting point is reduced in consequence. The following is a brief summary of the methods of examination adopted in determining the identity, purity, or commercial value of the various fixed oils, fats, and waxes. The physical properties, viscosity, specific gravity, melting and solidifying points, and solubility in various solvents are of great importance, while certain chemical methods to be described later are also commonly employed in the examination of oils, fats, and waxes.

VISCOSITY is observed by noting the weight or measure of oil flowing through a given orifice in a given time compared with some substance taken as standard, water or glycerin for example. Castor oil is one of the most viscid oils, and sperm oil one of the least viscid.

SPECIFIC GRAVITY is determined in the usual way by means of the specific gravity bottle or Sprengel tube. In the case of solid fats or waxes the specific gravity is taken by weighing a piece in air and water successively, or the specific gravity may be observed at temperatures above their melting points by immersing the bottle containing the melted substance in hot water of known temperature. This is most conveniently done at the temperature of boiling water. The specific gravity of oils and fats, even when pure, varies sufficiently to render this observation in some cases useless for the detection of adulteration, especially when the adulterant has nearly the same specific gravity, or when two adulterants, one higher and the other lower, are judiciously combined.

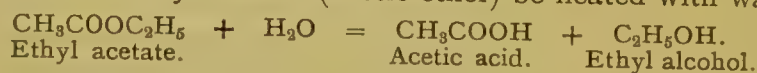
MELTING AND SOLIDIFYING POINTS are determined in the usual ways. It is necessary to remark that the solidifying point is affected a good deal by the temperature to which the substance has been previously heated, and also that owing to the variation in composition the melting and solidifying points of a given oil vary sometimes within fairly wide limits.

SOLUBILITY.—Oils, fats, and waxes are almost entirely insoluble in water or cold alcohol. Boiling absolute alcohol dissolves many of them, the greater part being re-deposited on cooling. The oils most soluble in alcohol are those



containing glycerides of the lower fatty acids, and linolein. The free fatty acids are mostly soluble in alcohol, so that fatty bodies containing any of those free acids will be partially soluble in this solvent. Castor and croton oils are also exceptionally soluble in alcohol. Ether, petroleum ether, benzene, chloroform, carbon bisulphide, and turpentine dissolve most substances of this class with facility.

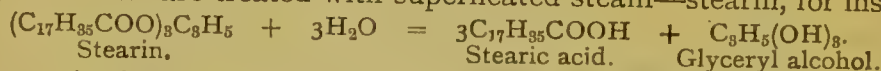
SAPONIFICATION is carried out by treatment with a fixed alkali—potash or soda—and gives very valuable indications, both as to the actual constitution of the substance and its freedom from adulteration. The term “saponification” is now used to describe the hydrolysis of any ester, although it had its origin in the decomposition of oils by caustic alkali in making soap. In its widest significance it now indicates the decomposition of an ester into alcohol and acid. For instance, if ethyl acetate (acetic ether) be heated with water—



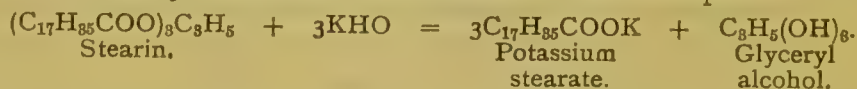
The following graphic representation makes the nature of this hydrolytic action very clear—



Similarly, when fats are treated with superheated steam—stearin, for instance—

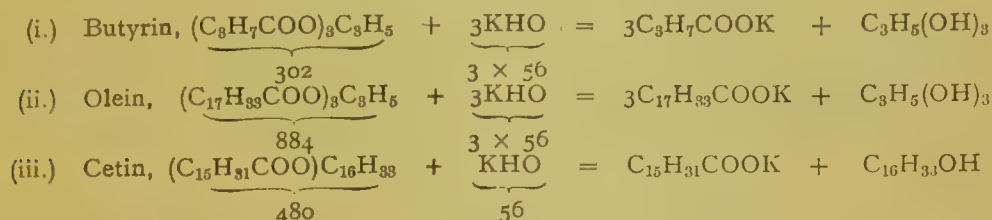


It will be noticed that these two reactions are precisely similar, only in one case we have a monovalent radical, ethyl  $\text{C}_2\text{H}_5$ , and consequently a monohydric alcohol, and in the other a trivalent radical, glyceryl  $\text{C}_3\text{H}_5$ , which produces a trihydric alcohol. The saponification of fats is more easily produced by heating with aqueous solutions of caustic alkalies, and still more so by alcoholic solutions. The fats being more or less soluble in alcohol, react more readily with the alkali. In the examination of fats the saponification is carried out by heating about 5 grammes of oil or fat with an alcoholic solution of potassium hydroxide in excess. When all oily globules have disappeared the product is evaporated to remove alcohol, and the residue contains the potassium salt of the fatty acids present and the equivalent quantity of alcohol whose hydrocarbon radical was previously combined with the acid. For example—



The residue is now dissolved in hot water and acidulated with hydrochloric acid, which liberates the fatty acids. These being insoluble and lighter than water rise to the surface and may be separated and examined. The aqueous fluid will contain the glycerin or other alcohols, and by suitable means those may be separated and examined. If the saponification be conducted quantitatively the amount of alkali required to saponify the quantity of oil treated can easily be determined. This is accomplished by using a known quantity of potassium hydroxide for saponification, and when saponification is complete, determining the residual alkali by titration with standard acid. The amount varies with different oils, etc., and furnishes valuable indications of their purity. It is correctly stated in grammes of oil saponified by 1 litre (1000 C.c.) of normal

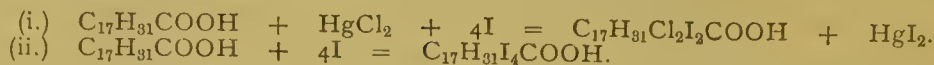
potassium hydroxide solution, this figure being known as the "saponification equivalent." The "saponification equivalent" for butyrin (glyceryl butyrate) is 100, while that for olein, the chief constituent of olive and almond oils, is 294. Spermaceti has a very high figure, about 440, since its chief constituent, cetin, is the palmitic ester of cetyl alcohol, a monohydric alcohol of high molecular weight. This will be rendered quite clear by examining the equations which represent the saponification of these three bodies.



From which one sees that one molecular weight in grammes of potassium hydroxide saponifies  $\frac{302}{3}$  grammes butyrin, or  $\frac{884}{3}$  grammes olein, or 480 grammes cetin, hence the saponification equivalents for these three substances are 100.6, 294.6, and 480 respectively. Paraffin wax, mineral oils, and bodies of this description composed of hydrocarbons, are not affected by boiling with potassium hydroxide solution; hence adulteration of animal and vegetable fats and waxes with those bodies is revealed by the diminished quantity of potash required for their saponification.

**IODINE ABSORPTION.**—It has been stated that the fatty acids whose esters constitute almost entirely the whole of the fixed oils, fats, and waxes belong with very few exceptions to three series—the acetic, acrylic, and propiolic. The members of the acetic series are saturated compounds, *i.e.*, they do not form additive compounds, whereas the acids of the other two series are unsaturated, and will combine respectively with two and four atoms of hydrogen or iodine (or other halogen), passing thereby into the corresponding acids of the acetic series in the case of addition of hydrogen or into iodine derivatives of these saturated acids if iodine be employed. For example, stearic acid,  $\text{C}_{17}\text{H}_{35}\text{COOH}$ , does not combine with iodine; oleic acid,  $\text{C}_{17}\text{H}_{33}\text{COOH}$ , combines with 2I to form  $\text{C}_{17}\text{H}_{33}\text{I}_2\text{COOH}$ ; and linoleic acid,  $\text{C}_{17}\text{H}_{31}\text{COOH}$ , with 4I to form  $\text{C}_{17}\text{H}_{31}\text{I}_4\text{COOH}$ . Compare the behaviour of ethane,  $\text{C}_2\text{H}_6$ , ethylene,  $\text{C}_2\text{H}_4$ , and acetylene,  $\text{C}_2\text{H}_2$ , with the halogens. Iodine is usually employed since the amount absorbed by an oil admits of fairly easy determination. The process is usually carried out in the following manner:—The oil dissolved in chloroform is treated with excess of alcoholic solution of iodine, and then, after standing several hours, water is added and the uncombined iodine determined by titration with volumetric solution of sodium thiosulphate. In practice some mercuric chloride is also added, the formation of the additive compounds being much expedited thereby. In this case the halogen addition product will contain chlorine as well as iodine, but this makes no difference from an analytical point of view, since the chlorine given up by the mercuric chloride is replaced by an

equivalent amount of iodine. Consider the following equations for linoleic acid—

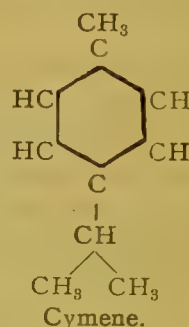


The amount of free iodine absorbed in the two cases is precisely the same. The iodine absorption is, therefore, indirectly a measure of the unsaturated fatty acid esters in an oil, and like the saponification test, a valuable means of determining the purity or extent of adulteration of oils, etc.

**ELÄIDIN TEST.**—When olein is treated with nitric acid it is converted into a solid isomeric substance called eläidin. The nature of the change is not well understood (*vide* Acidum Oleicum). An acid solution of mercuric nitrate has the same effect, as is seen in making Unguentum Hydrargyri Nitratis.

**Volatile or Essential Oils** are composed chiefly of substances belonging to the benzene (aromatic) series, the body to which the majority of those constituents are most nearly related being cymene, or para-methyl-iso-propyl-benzene. Benzene is  $\text{C}_6\text{H}_6$ , methyl-benzene is  $\text{C}_6\text{H}_5\cdot\text{CH}_3$ , methyl-propyl-benzene is  $\text{C}_6\text{H}_4(\text{CH}_3)(\text{C}_3\text{H}_7)$ , the methyl and propyl groups having each displaced an atom of hydrogen from the benzene nucleus. The name para-methyl-propyl benzene indicates that the two replacing groups occupy the para position to each other in the benzene ring, and the prefix “iso” shows that the propyl group is not normal propyl,

— $\text{CH}_2\text{—CH}_2\text{—CH}_3$ , but iso-propyl, — $\text{CH}$   $\begin{matrix} \text{CH}_3 \\ \diagup \\ \text{CH}_3 \end{matrix}$  isomeric



with normal propyl, but having the branched or iso-formation. An inspection of the formula shows what an immense variety of isomeric compounds can be derived from such a body as cymene by the replacement of different hydrogen atoms by the same group, OH, for example. Those derivatives would yield the same formula by analysis, but their physical properties, such as melting and boiling points, would exhibit certain differences, and their chemical behaviour would also vary with the various positions taken up by the replacing group. The terpenes having the formula  $\text{C}_{10}\text{H}_{16}$  are mostly di-hydro-cymenes, that is, they are derived from cymene,  $\text{C}_{10}\text{H}_{14}$ , by the addition of two atoms of hydrogen. This can be accomplished artificially by submitting cymene to the action of reducing agents. Although the terpenes stand in such close relationship to cymene, the conversion of cymene into a terpene, by the addition of two hydrogen atoms, probably produces a profound alteration in the internal structure of the molecule: for while cymene undoubtedly contains a typical aromatic nucleus the terpenes are now regarded as derivatives of hexamethylene. The hexamethylene compounds, although containing a six carbon ring, do not exhibit the stability of the benzene compounds, and are now regarded as belonging to a group of compounds occupying a position between the aliphatic or open-chain compounds and the benzene compounds. To recall the fact that such bodies, while containing a closed carbon chain, yet approach the aliphatic compounds in chemical behaviour, they have been named the alicyclic group.

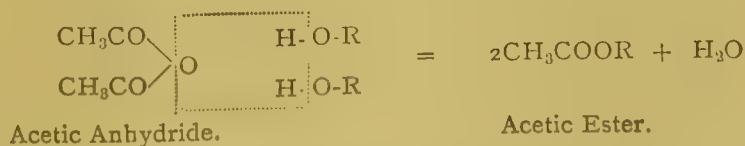


Many isomeric terpenes are known, limonene in lemon oil and menthene in peppermint oil for example. Turpentine consists almost entirely of a terpene. Besides the terpenes essential oils contain various oxidised derivatives, alcohols, aldehydes, and esters, and their aroma chiefly depends upon these. Recently, so-called terpeneless or "concentrated" essential oils have been introduced into commerce. They consist of the oxygenated derivatives separated from the accompanying terpenes by fractional distillation under diminished pressure. The terpenes, which have little value as flavouring or odoriferous bodies, and act as diluting agents, having a lower boiling point than the more valuable alcohols, aldehydes, etc., come over first, and leave a residue in the still more powerful in flavour and odour than the entire oil, in consequence of the removal of the bulk of the comparatively valueless terpene. Lemon oil by careful fractionation can be separated into about 90 per cent. of limonene and nearly 10 per cent. of aldehydes, citral and citronellal, with traces of other bodies to which its flavour is due. The distillation is usually accomplished under diminished pressure, so as to lower the boiling point of the terpene, for some of the oxygenated substances, particularly the esters, decompose at the temperature at which the terpenes boil under ordinary atmospheric pressure. The commercial and medicinal value of the essential oils depends, therefore, chiefly on the non-terpene portion of the oil, so that various—mostly well-known—processes commonly employed in organic chemistry have been adapted for the determination of the percentage of the more important bodies present in the various essential oils.

### METHODS OF EXAMINATION.

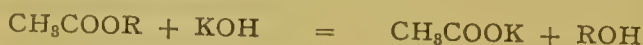
**ALDEHYDE DETERMINATION.**—The determination of aldehydic bodies is made by utilising the well-known property of aldehydes to form definite compounds with acid sodium sulphite. The oil is shaken up with a strong solution of that compound, which abstracts any aldehydic constituent, and after adding sufficient water to dissolve the compound formed, the non-aldehyde portion is measured; the difference between this and the volume of oil taken represents the amount of aldehyde present. Examples of aldehydes in oils are citral in lemon oil, cinnamic aldehyde in cinnamon and cassia, and benzoic aldehyde in bitter almond oil. For the constitution of the aldehyde and acid sulphite compounds some modern book on organic chemistry should be consulted.

**ALCOHOL DETERMINATION.**—For the determination of alcohols advantage is taken of the capacity which is shown by bodies containing a (OH) hydroxyl group to react with acetic anhydride to form the acetic ester of the hydrocarbon radical of the alcohol. If this radical be represented by R the following shows the nature of the reaction—



In the case of ordinary alcohol, R in the general formula above would be  $\text{C}_2\text{H}_5$ , for menthol  $\text{C}_{10}\text{H}_{19}$ , since the formulæ of these two alcohols are respectively,

$C_2H_5OH$ , and  $C_{10}H_{19}OH$ . The oil containing a free alcohol, such as peppermint oil or santal oil, is therefore treated with excess of acetic anhydride and anhydrous sodium acetate. The latter facilitates the reaction by absorbing the water which is liberated during "acetylation," as the process is called. The next step is to remove the excess of acetic anhydride and sodium acetate. This is done by washing with water in a separating funnel. The washed oil will now contain an amount of acetic ester equivalent to the amount of alcoholic body previously present. It is next boiled in a flask with a reflux condenser with a known quantity of potassium hydroxide in alcoholic solution. This hydrolyses the acetic ester thus—



—again liberating the alcohol from the ester. The quantity of potassium hydroxide which is used up during the hydrolysis can be determined by titrating with standard acid at the end of the reaction. By deducting this amount from the known quantity added it is possible to find how much potassium hydroxide has been consumed by the hydrolysis of the ester, and by the equation already given the quantity of alcohol can be easily found, for every 56 parts (molecular weight KOH) is equivalent to one molecular weight of the alcohol. Besides menthol, santalol, geraniol, linalool, and other alcohols are thus determined.

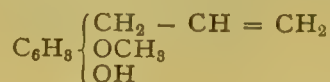
ESTER DETERMINATION.—The esters occurring in some essential oils are determined by simple saponification with potash, and from the weight of potassium hydroxide required the equivalent amount of ester can be deduced. Peppermint oil contains, in addition to menthol, menthyl acetate and menthyl valerianate, *i.e.*, the radical  $C_{10}H_{19}$  of the alcohol, menthol  $C_{10}H_{19}OH$ , combined with acetic and valerianic acid respectively, just as ethyl acetate is a combination of the radical ethyl,  $C_2H_5$  (from ethyl alcohol,  $C_2H_5OH$ ), with acetic acid. When peppermint oil is treated with potassium hydroxide, these two esters are decomposed—



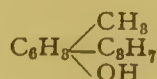
potassium acetate and valerianate being produced, while menthol is liberated. In precisely the same way ethyl acetate is hydrolysed, as here shown—



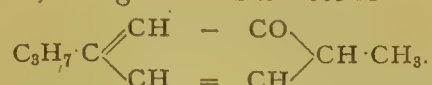
OTHER CONSTITUENTS.—In addition to the compounds already mentioned there are several constituents of essential oils which are regarded as phenols. Thus eugenol, the chief constituent of clove and pimento oils, is para-oxy-methoxy-allyl-benzol—



Since it forms a soluble compound with aqueous solution of potassium hydroxide, the amount present in an oil such as clove oil may be determined by treating a known volume of the oil with potassium hydroxide solution and determining the amount of "non-phenol" left undissolved. Thymol is another phenol, methyl-propyl-phenol—



Carvol, on the other hand, is regarded as a ketone—



It is the chief constituent of caraway oil, existing in a dextro-rotatory form, while in oil of spearmint it occurs as lævo-rotatory carvol. The composition of an essential oil varies considerably, the variations being the result of a number of factors, *e.g.*, the season, the place of origin of the plant from which the oil has been distilled, and the part of the plant used. Consequently it is difficult to give exact tests for their purity, but the specific gravity and rotatory effect on polarised light are valuable indications. Those, with fractional distillation and a determination of the known constituents, are generally relied upon. Figures are given for the specific gravity and specific rotatory power of most of the oils, as well as their solubility in alcohol. In certain cases also special tests are given for the determination of certain bodies which are held to constitute the most important fractions of the oils. In technical works dealing with essential oils the following terms will be found: acid number, ester number, and saponification or total acid number. The acid number is the number of milligrammes of potassium hydroxide required to neutralise the free acid in 1 gramme of the oil; the ester number gives the number of milligrammes of potassium hydroxide required to saponify the total esters in 1 gramme of oil, while the saponification or total acid number is the sum of the acid and ester numbers. It will be observed that there is a difference between this method of stating these constants for the essential oils and the definition already given for very similar terms in relation to fixed oils (see page 299).

## Oleum Amygdalæ.

**Almond Oil** is obtained by expression from both bitter and sweet almonds, but the almond oil of commerce is obtained chiefly from bitter almonds, as they also yield a volatile oil, and the fixed oil can, therefore, be expressed more profitably from them—before distilling the volatile oil—than from sweet almonds. The seeds are freed from the reddish-brown powder adhering to their surface, after which they are ground in a mill and then subjected to hydraulic pressure, the turbid oil thus obtained being allowed to settle and subsequently filtered to effect complete clarification, after which it is sometimes bleached by exposure to light or by other means.

**Characters and Tests.**—Almond oil is pale yellow in colour, nearly inodorous, and has a bland, nutty taste. It is soluble in all proportions of chloroform and freely soluble in ether (1 in 2.25), but only slightly soluble in 90 per cent. alcohol. It does not congeal until cooled to nearly  $-20^{\circ}\text{C}$ ., and its specific gravity ranges from 0.915 to 0.920. The solubility, specific gravity, and congelation point of the oil serve as physical tests of its purity; the last, in particular, serves to distinguish the oil from olive and lard oils, as they begin to congeal at a much higher temperature than almond oil, owing to the larger proportion of palmitin and stearin they contain. Almond oil may



be adulterated with other fixed oils, but it is more common to find peach or apricot kernel oils, in a more or less pure condition, substituted for it. To prove the absence of such adulterants or substitutes, 2 C.c. of the oil should be well shaken with 1 C.c. of fuming nitric acid and 1 C.c. of water. If the almond oil be pure, a whitish mixture forms and, after standing for six hours at a temperature of about 10° C., that separates into a solid white mass (eläidin, the solid isomer of olein) and a nearly colourless liquid; if, however, a brownish-red mixture should be formed on shaking the oil with the acid and water, the presence of peach kernel oil or some other fixed oil is indicated.

**Notes.**—Sweet almonds contain about 45 per cent. of fixed oil, but bitter almonds contain only about 38 per cent. The oil consists chiefly of olein, with a small proportion of the glyceride of linolic acid, and other glycerides, and some phytosterol; but contains no stearin. It is very similar in composition to olive oil, but is free from chlorophyll, and usually contains a somewhat larger proportion of olein, as indicated by its higher iodine absorption (93 to 101). The test with fuming nitric acid is a variety of the eläidin test, which depends upon the production of eläidin, a solid body isomeric with fluid olein. A similar reaction is undergone by oleic acid, which forms a solid isomeric eläidic acid when acted upon by nitrous acid. The reaction can be brought about by passing into the oil nitrous fumes (from arsenious anhydride and nitric acid); by heating with ordinary strong nitric acid; by the action of a freshly prepared solution of mercuric nitrate containing nitrous acid (*vide* Ung. Hydrargyri Nitratis); or by the action of fuming nitric acid in the cold. The actual means adopted must be carefully defined, in order to make the test of comparative value in the examination of oils, since the proportions of oil and acid, temperature of reaction, etc., considerably modify the rate of reaction as well as the appearance of the final products. The chemical relationship of eläidic acid to oleic acid is not well understood, but is believed to depend upon a shifting in the carbon chain of the position of the double bond which oleic acid contains, since it is a derivative of an unsaturated hydrocarbon of the ethylene series. This change in the position of the double bond is explained by the formation of an unstable additive compound from the nitrous and oleic acids, which splits up immediately, regenerating the nitrous acid and eläidic acid, an isomer of oleic acid in the sense described above. The official test (using fuming nitric acid) serves to detect (1) oils which are poor in olein and do not form a solid separable mass, but a pasty semi-fluid one, (2) oils of the linseed class (drying oils), which give liquid products, (3) peach- and apricot-kernel oils, which are products giving usually a brown or yellow colour. Peach-kernel or apricot-kernel oil is largely sold under the name of "oleum amygdalæ persicæ," or "ol. amygd. exot." The oil expressed from small almonds appears to solidify less rapidly and less completely, on the application of the eläidin test, than that obtained from larger seeds; thus, a sample of oil expressed from sweet almonds was found to congeal almost completely, and about twelve hours sooner than that obtained from the smaller bitter almonds, while only about one-third of the bulk solidified in the case of oil expressed from small sweet almonds.

## Oleum Anethi.

**Oil of Dill** is obtained by distillation from dried, ripe dill fruit, the vittæ or oil glands of which yield about 3 to 4 per cent. The oil distilled in England is most esteemed and usually has a higher specific gravity (from 0.910 to 0.916) than German oil; the oil obtained from Indian dill contains much less carvone than ordinary oil of dill, and is said to contain dill-apiol (b.p. 285°), a body isomeric with ordinary apiol, the presence of which causes the specific gravity of the oil to be very high, varying from 0.945 to 0.970.

**Characters and Tests.**—Oil of dill is of a pale yellow colour, possesses an agreeably aromatic odour, and has a sweet aromatic taste. It is readily soluble in alcohol and ether, and its specific gravity is usually between 0.905 and 0.920. The oil rotates the plane of a ray of polarised light not less than 70 degrees to the right, at 15.5° C., in a tube 100 Mm. long.

**Notes.**—The oil of dill consists almost entirely of dextro-limonene (carvene) and carvone (carvol), an unsaturated ketone isomeric with the phenols carvacrol and thymol. Traces of a paraffin hydrocarbon have also been found in the oil, and some English and Spanish oils have been stated to contain phellandrene, an unstable terpene which has not yet been obtained in the pure state; it is found in many other volatile oils, and may occur in both dextro- and lævo- modifications. Carvone (b.p. 230° C.) is the most important constituent of the oil and should be present to the extent of 40 to 60 per cent.; most of the limonene in the oil distils below 180° C. Oil of dill is almost identical in composition with oil of caraway, but contains less carvone. [*Dose.*— $\frac{1}{2}$  to 3 minims.]

## Oleum Anisi.

**Oil of Anise** is obtained by distillation from either dried, ripe anise fruit, or from the fruit of the star-anise, *Illicium verum*, Hooker filius (N.O. Magnoliaceæ), a small tree indigenous to the southern and south-western provinces of China. The oil exists in the vittæ of *Pimpinella Anisum*, to the extent of 1.5 to 6 per cent., and in large oil-cells in the fruit and seeds of *Illicium verum*, to the extent of 2.5 to 5 per cent. The bulk of the commercial oil is obtained from the star-anise, being distilled in crude native stills in China and Tonkin, and thence exported to Europe, frequently in a grossly adulterated condition.

**Characters and Tests.**—Oil of anise is colourless or pale yellow, with an agreeably aromatic odour and a mildly aromatic taste. It dissolves in all proportions of absolute alcohol, in 3 to 4 parts of 90 per cent. alcohol, and in about 20 parts of 60 per cent. alcohol, the oil of star-anise being less soluble than the other variety. The specific gravity of the oil at 20° C. (not 15.5° C., as usual in the B.P.) is 0.975 to 0.990; at lower temperatures it is sometimes difficult to keep the oil liquid, though the point at which congelation is officially stated to take place, when the oil is stirred, is from 10° to 15° C. As the melting point of the previously solidified oil is more constant than the solidifying point the former is of greater value as a test. The stirring is necessary, because the anethol in the oil has a great tendency to remain in a state of superfusion, so that, if not agitated, the oil may be cooled below its normal solidifying point

without becoming solid. After congelation, the oil should not again become liquid below  $15^{\circ}$  C.; if it does, some adulterant is present or part of the anethol has been removed. Oil of anise usually rotates the plane of a ray of polarised light slightly to the left, the slight negative rotation being characteristic; dextro-rotation probably indicates the presence of oil of fennel.

**Notes.**—The usual adulterants of oil of anise are petroleum, fennel oil or its stearoptene, and the waste liquid portion of oil of anise left after the extraction of anethol. Spermaceti, wax, and camphor are also said to have been found as adulterants of the oil, but spermaceti and wax are insoluble in alcohol, and camphor can be detected by its odour. The melting point of the congealed oil affords the best test of purity, but the behaviour of the oil on fractionation also yields valuable information on that point. The fraction obtained between  $225^{\circ}$  and  $235^{\circ}$  should amount to no less than 80 per cent., corresponding to the amount of anethol (b.p.  $232^{\circ}$  C.) present. Anethol is the chief constituent of the oil, of which it may constitute as much as 90 per cent.; it is the methyl ether of para-propenyl phenol, or para-methoxy-propenyl benzene,  $\text{CH}_3\text{O}\cdot\text{C}_6\text{H}_4\cdot\text{CH}=\text{CH}-\text{CH}_3$ . On cooling the oil, the anethol separates in the form of shining, white scales which melt at  $21^{\circ}$  C. In addition to anethol, ordinary oil of anise contains the isomeric methyl-chavicol, which is the analogous allyl compound and yields anethol when heated with alcoholic potassium hydroxide solution. Other constituents of the oil are anisic aldehyde and anisic acid, two oxidation products of anethol, which increase in quantity with the age of the oil. Star anise oil contains anethol, methyl-chavicol, dextro-pinene, traces of anisic aldehyde and anisic acid, lævo-phellandrene, the ethyl ether of hydroquinone, and probably safrol. A saturated solution of hydrochloric acid gas in absolute alcohol is said to produce a blue or red colour—according to the strength of the acid solution—with ordinary anise oil, while star anise oil is coloured yellow or brown by the same reagent, but the test is not to be depended upon. [Dose.— $\frac{1}{2}$  to 3 minims.]

## Oleum Anthemidis.

**Oil of Chamomile** is obtained by distillation from the dried flowers of *Anthemis nobilis*, Linné, which yield from 0.8 to 1 per cent. It is known as Roman chamomile oil, in contradistinction to German chamomile oil, distilled from the flowers of *Matricaria Chamomilla*, Linné.

**Characters.**—Oil of chamomile is pale blue or greenish-blue when freshly distilled, but becomes greenish-yellow to yellowish-brown on keeping. It is only sparingly soluble in water, but is freely soluble (10 in 3) in 90 per cent. alcohol. The aromatic odour and taste of the oil are identical with those of chamomile flowers, but more pronounced. The specific gravity—0.905 to 0.915—distinguishes the oil from that of *Matricaria Chamomilla*, the specific gravity of which varies from 0.930 to 0.940.

**Notes.**—The composition of oil of chamomile is very complex, an unusual proportion of aliphatic esters being present. The oil possesses only a slight



optical activity, and consists chiefly of esters of the isomeric angelic and tiglic acids. It contains isobutyl isobutyrate and angelate, amyl angelate and tiglate, hexyl angelate and tiglate, and possibly esters of an alcohol named anthemol,  $C_{10}H_{15}OH$ . A crystalline hydrocarbon, named anthemene, has also been extracted from the oil, and traces of free alcohols and acids have been detected, being probably due to the decomposition of esters during distillation. German oil of chamomile, from *M. Chamomilla*, is a thick fluid which becomes more or less solid at  $0^{\circ}C$ . It contains esters of caproic acid, decomposition products of those esters, and a solid hydrocarbon, or mixture of hydrocarbons, of the paraffin series. The oils of cedar, turpentine, copaiba, and milfoil have been used to adulterate oil of chamomile, and some commercial oil is said to consist merely of turpentine or lemon oil, or a mixture of those oils, distilled over chamomiles. [Dose.— $\frac{1}{2}$  to 3 minims.]

## Oleum Cadinum.

**Oil of Cade or Juniper Tar Oil** is an empyreumatic oily liquid obtained by the destructive distillation of the woody portions of the prickly cedar, *Juniperus Oxycedrus*, Linné (N.O. Coniferæ), and possibly of other species of *Juniperus*. The oil is prepared chiefly in the South of France, near Nismes and Toulon, by a process of downward distillation, similar to that employed in preparing tar. The heart-wood and other woody portions of the trees are cut into small pieces, and those are carefully laid upon one another in such a way that combustion can take place freely when the pile is ignited, without too free access of air being permitted. The burning pile is, therefore, kept enclosed in a covered pit or kept covered up with earth, and the liquid product of this crude method of dry distillation is collected as it descends.

**Characters and Tests.**—Oil of cade is a dark reddish-brown or nearly black, more or less viscid, oily liquid (specific gravity about 0.990). It has a distinctive, empyreumatic or tarry odour and a somewhat aromatic, bitter, acrid taste. The oil mixes in all proportions with ether or chloroform, and is almost wholly soluble in hot, though only partially soluble in cold, 90 per cent. alcohol. It is very slightly soluble in water; the filtered aqueous solution or extract should be yellowish or almost colourless and possess an acid reaction, owing to the presence of acetic acid, whereas an aqueous solution of coal-tar is darker coloured and possesses an alkaline reaction. The filtered aqueous extract of oil of cade also assumes a reddish colour with very dilute solution (0.1 per cent.) of ferric chloride, whereas an aqueous extract of birch tar assumes a greenish colour with that reagent; with a 5 per cent. solution of ferric chloride, the aqueous extract of oil of cade assumes an olive-brown colour, but a similar extract of ordinary wood-tar becomes dark olive green.

**Notes.**—Wood-tar is more viscid and of higher specific gravity (1.02 to 1.15) than oil of cade, the specific gravity of which may be slightly higher than 0.990 in old specimens. Oil of cade is not completely soluble in 95 per cent. acetic acid, but pine and beech tars are completely soluble. A sesquiterpene named cadinene—which is also found in the oils of patchouli, galbanum, etc.—occurs in oil of cade, together with certain phenols.

## Oleum Cajuputi.

**Oil of Cajuput** is obtained by distillation from the leaves of *Melaleuca Leucadendron*, Linné (N.O. Myrtaceæ), a plant of which *M. cajuputi*, Roxburgh, is understood to be a smaller variety. The oil is prepared largely in the islands of Amboyna, Banda, and Bouro, and is chiefly imported in glass bottles from Batavia and Singapore.

**Characters and Tests.**—Oil of cajuput (specific gravity, 0·922 to 0·930) has a fine bluish-green colour and an agreeable, penetrating, camphoraceous odour. The taste is also aromatic, somewhat bitter, and camphoraceous. The oil is soluble in all proportions of 90 per cent. alcohol, and should become semi-solid on being stirred, when cold, with one-third or one-half its volume of phosphoric acid (specific gravity, 1·750), thus indicating the presence of a due proportion of cineol, with which the acid forms a crystalline compound.

**Notes.**—The oil of cajuput is almost optically inactive, and consists chiefly of cineol (cajuputene hydrate or cajuputol) or eucalyptol, which should be present to the extent of 45 to 55 per cent. Other constituents of the oil are terpineol and terpinyl acetate, butyric, valeric and benzoic aldehydes, and lævo-pinene. At least 60 per cent. of the oil should distil between 175° and 185°. The green colour of the oil has been attributed to the presence of copper, but that is probably not invariably the cause of the coloration. The oil can be obtained free from colour by redistillation, or the green tint can be removed almost entirely by shaking 5 C.c. of the oil with 5 C.c. of water containing a drop of dilute hydrochloric acid. The specific gravity of the oil is lowered by adulteration with turpentine or by abstraction of cineol. Oil of rosemary is said to have been used as an adulterant of oil of cajuput, as well as oil of turpentine impregnated with camphor and coloured with the resin of milfoil. Oils which are almost identical with that obtained from *M. Leucadendron* are yielded by other species of *Melaleuca*, including *M. minor*, *M. uncinata*, *M. acuminata*, and *M. viridiflora*; those are oils very similar in composition, but all differ more or less in their physical characters. [Dose.— $\frac{1}{2}$  to 3 minims.]

## Oleum Carui.

**Oil of Caraway** is obtained by distillation from caraway fruit, in the vittæ of which it occurs to the extent of about 3 to 7 per cent., according to the variety. The oils distilled from English and Dutch fruit are most esteemed. Much of the oil from German fruit fails to meet the official requirements, its specific gravity being too low.

**Characters.**—Oil of caraway is colourless or pale yellow, with the characteristic odour of caraway fruit and a mild spicy taste. Its colour darkens with age, and its specific gravity should vary from 0·910 to 0·920. A lower specific gravity indicates a deficiency in the proportion of carvone present.

**Notes.**—Much of the German oil of caraway falls below specific gravity 0·910, part of the carvone (specific gravity, 0·960) having frequently been removed in such cases. Carvone (carvol) is the chief constituent of oil of caraway, and is present to the extent of 50 to 60 per cent.; the greater the

proportion of that ketone present, the higher is the specific gravity of the oil and the greater its solubility in 50 per cent. alcohol. Carvone is miscible in all proportions with 90 per cent. alcohol, and forms a clear solution with twice its volume or less of 70 per cent. alcohol, or with fifteen to twenty volumes of 50 per cent. alcohol, but carvone containing 2 per cent. of limonene will not dissolve clearly in twenty parts of 50 per cent. of alcohol. Oil of caraway boils from  $175^{\circ}$  to  $230^{\circ}$  C. The carvone in the oil, like that in oil of dill, occurs as dextro-carvone, and the oil itself is dextro-rotatory, its optical rotation being about  $+80^{\circ}$ . In addition to carvone, practically the only other constituent of oil of caraway is dextro-limonene (carvene), though traces of carvacrol may also be present. [Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Caryophylli.

**Oil of Cloves** is obtained by distilling dried cloves with water. The oil is contained in glands which occur chiefly in the solid, fleshy, lower part of the flower-bud, also in the calyx-teeth and in the petals; as much as 15 to 20 per cent. can be obtained from the buds, but the dried peduncles, or "clove-stalks," do not yield more than about 6 per cent.

**Characters and Tests.**—Oil of cloves (specific gravity, 1.050 to 1.070) is colourless or pale yellow when recently distilled, but it gradually becomes reddish-brown on keeping. It is soluble in 2 parts of 70 per cent. alcohol, and in all proportions of 90 per cent. alcohol, ether, or strong acetic acid. The strong odour and taste resemble those of cloves. The oil should be regarded with suspicion if its specific gravity be lower than 1.050. An alcoholic solution of the oil yields a characteristic blue colour with a 5 per cent. solution of ferric chloride, the reaction being due to the presence of eugenol, a compound which also forms a semi-solid yellowish mass or jelly, owing to the formation of crystalline eugenol-ammonium, when oil of cloves of good quality is shaken with its own volume of strong solution of ammonia.

**Notes.**—Eugenol is the chief oxygenated constituent of oil of cloves, and the proportion of that phenol present may be approximately determined by agitating the oil with 10 per cent. potassium hydroxide solution, and subsequently weighing or measuring the undissolved oily residue. The high specific gravity of oil of cloves is indicative of the high eugenol (specific gravity, 1.070) content of the oil, which consists almost entirely of eugenol (85 to 90 per cent.) and the sesquiterpene caryophyllene (specific gravity, 0.908), in addition to traces of methyl alcohol, furfural, acetyl-eugenol, salicylic acid, vanillin, and methyl amyl ketone. The last-mentioned compound is supposed to be the body to which the fruity odour of the oil is due. Traces of vanillin are said to have been found in oil of cloves, and eugenol can be converted into vanillin by oxidation, though in practice vanillin is best made from isoeugenol, into which eugenol is converted by treating it with alcoholic potassium hydroxide solution. The oil is faintly lævo-rotatory, usually under  $-1^{\circ}$ , and yields no considerable fraction below  $245^{\circ}$  C. If alcohol be present as an adulterant, it will distil over below  $100^{\circ}$  C. Absence of turpentine, petroleum, and most fixed oils is proved



by the ready solubility of the oil in 90 per cent. alcohol. Other possible adulterants are the oils of pimento and copaiba, both of which, like the fixed oils, affect the specific gravity and boiling point of oil of cloves with which they are mixed.

[Dose.— $\frac{1}{2}$  to 3 minims.]

## Oleum Cinnamomi.

**Oil of Cinnamon** is obtained by distillation from cinnamon bark, being prepared in Ceylon from the small fragments or chips left after preparing the bark for market, or from inferior kinds of cinnamon, the pieces being coarsely powdered, macerated in sea-water for two or three days, and then submitted to distillation. The trimmings (cinnamon chips) are sometimes exported as such, and the oil is distilled from them in England. The bark yields from 0.5 to 1 per cent. of oil, which possesses the aromatic and antiseptic properties of the drug without its astringency.

**Characters and Tests.**—Oil of cinnamon (specific gravity, 1.025 to 1.035) is yellow when freshly distilled, but gradually becomes reddish; it has the fragrant, characteristic odour, and the warm, sweet, aromatic taste of cinnamon bark. It is very soluble in 90 per cent. alcohol (10 in 3), and also soluble in 70 per cent. alcohol (1 in 2). On dissolving 1 C.c. of the oil in 5 C.c. of 90 per cent. alcohol and adding 5 per cent. solution of ferric chloride, the coloration produced should be pale green. The coloration depends upon the presence of eugenol, of which oil of cinnamon should not contain more than 8 per cent. The production of a decided blue coloration is supposed to indicate the presence of cinnamon leaf oil, which is as rich in eugenol as oil of cloves, and therefore gives a much deeper colour with ferric chloride. The amount of cinnamic aldehyde present in oil of cinnamon is indicated by well shaking 10 C.c. of the oil with 50 C.c. of a hot solution (30 per cent.) of sodium hydrogen sulphite contained in a flask immersed in boiling water; the oily layer which separates on cooling should not measure more than 5 C.c., thus indicating the absence of more than 50 per cent. of constituents other than aldehydes. Oil of cinnamon is only very slightly lævo-rotatory, from  $-0.5^{\circ}$  to  $-1^{\circ}$ .

**Notes.**—The chief constituent of oil of cinnamon is about 50 per cent. of cinnamic aldehyde, a compound which may be converted into cinnamic and benzoic acids by oxidation. The proportion of cinnamic acid varies according to the age of the oil. The oil also contains phellandrene, eugenol (4 to 8 per cent.), methyl-*n*-amyl ketone, pinene, cymene, furfural, benzaldehyde, nonyl aldehyde, cumic aldehyde, linalool, caryophyllene, and probably hydrocinnamic aldehyde and linalyl isobutyrate. Cinnamon leaf oil is of specific gravity 1.045 to 1.060, slightly dextro-rotatory, and contains from 75 to 85 per cent. of eugenol, together with traces of cinnamic aldehyde (about 1 per cent.), and some safrol and benzoic aldehyde, whilst benzoic acid is said to have been found. Oil of cassia (specific gravity, 1.050 to 1.065) is almost identical in composition with oil of cinnamon, but is richer in cinnamic aldehyde, of which it may contain from 75 to 90 per cent.; it also contains cinnamic acid, a terpene, a compound of cinnamic and acetic acids, cinnamic acid esters, and

an aldehyde of methyl-coumaric acid. Cassia oil is almost inactive optically, is soluble in its own volume of glacial acetic acid or 90 per cent. alcohol, and in most cases forms a clear solution with 3 or 4 volumes of 70 per cent. alcohol, though some otherwise good oils produced turbid, opalescent solutions when so mixed, probably owing to the presence of zinc cinnamate. A brown colour is produced when a drop of 10 per cent. solution of ferric chloride is added to a solution of 4 drops of oil of cassia in 10 C.c. of strong alcohol, and it is believed to be possible thus to detect an admixture of 1 part of oil of cassia with 2 parts of oil of cinnamon. [Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Copaibæ.

**Oil of Copaiba** is obtained by distillation from copaiba oleo-resin, of which it usually constitutes from 40 to 60 per cent. or more, as much as 80 per cent. having been yielded by the drug. The oil which first comes over is colourless, but the later product has a fine greenish hue, which can only be removed by redistillation.

**Characters and Tests.**—Oil of copaiba (specific gravity 0.900 to 0.910) should be colourless or pale yellow, with the odour and taste of the oleo-resin from which it is obtained. The oil is distinguished from that of African copaiba by turning the plane of a ray of polarised light to the left instead of the right, and by dissolving in its own volume of absolute alcohol. It also dissolves in 20 parts of 90 per cent. alcohol, but is nearly insoluble in 60 per cent. alcohol.

**Notes.**—The distinctive characters of oil of copaiba are its odour, taste, and lævo-rotatory action upon polarised light. It should also have a neutral reaction, and boil between 250° and 275° C. Oil of African copaiba (specific gravity, 0.918) is dextro-rotatory and does not dissolve completely in either absolute or 90 per cent. alcohol. The chief constituent of oil of copaiba is caryophyllene, identical with that which exists in oil of cloves; a crystalline acid has also been found in the oil. [Dose.—5 to 20 minims.

## Oleum Coriandri.

**Oil of Coriander** is obtained by distillation from dried, ripe coriander fruit, the yield being nearly 1 per cent. The ripe fruit, distilled immediately after harvesting, yields an oil of pure coriander odour, whereas the product of immature fruit has an objectionable subsidiary odour, recalling that of bugs.

**Characters and Tests.**—Oil of coriander (specific gravity, 0.870 to 0.885) is colourless or pale yellow, with the odour and flavour of coriander fruit. It dissolves in half its volume of 90 per cent alcohol, or in 75 parts of 60 per cent. alcohol. The absence of oil of turpentine and added terpenes is indicated by 1 C.c. of the oil forming a clear solution with 3 C.c. of 70 per cent. alcohol.

**Notes.**—The chief constituents of oil of coriander are the alcohol dextro-linalool (coriandrol), and dextropinene; the former, which is isomeric with geraniol, and belongs to one of the unsaturated aliphatic series, is present in the oil to the extent of about 90 per cent. Although an open-chain compound, it can easily be transformed into the closed-chain cymene. [Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Crotonis.

**Croton Oil** is obtained by expression from the seeds of *Croton Tiglium*, Linné (N.O. Euphorbiaceæ), a small tree or shrub, which is cultivated in India, where it is indigenous. The seeds are oblong and of a dull cinnamon-brown colour, with an oily kernel which consists of a large endosperm enclosing papery cotyledons and a small radicle. The seeds contain toxic albumoses resembling ricin and more than 50 per cent. of fixed oil, which is extracted by expression, in India or England, after removal of the shells.

**Characters and Tests.**—Croton oil (specific gravity 0.940 to 0.960) is a viscid, brownish-yellow to dark reddish-brown fluid, with a disagreeable odour and an acrid, burning taste. It is officially stated to be entirely soluble in absolute alcohol, but when more than an equal bulk of alcohol is added to recently-expressed oil a turbid and separable mixture results. The oil is freely soluble in ether, chloroform, carbon bisulphide, and fixed or volatile oils, but only partially soluble in 90 per cent. alcohol. The solubility in alcohol appears to depend upon the proportion of free acids present, and increases with the age of the oil. The official statement that an alcoholic solution should not redden moistened blue litmus paper is intended to guard against the use of oil which has been kept too long, since old oil is acid and more irritant than the nearly neutral, freshly-expressed oil. The absence of other non-drying oils, such as castor oil, is proved by the non-solidification, after vigorous shaking, of a mixture of 2 C.c. of the oil with 1 C.c. each of fuming nitric acid and water; in the case of pure croton oil the mixture should only thicken slightly after standing for two days.

**Notes.**—The oil from croton seeds may contain various free fatty acids—stearic, palmitic, myristic, lauric, valeric, butyric, acetic, formic, oleic, and tiglic—and glycerides of those acids, but the active portion of the oil can be extracted as a viscid oily mixture, named crotonoleic acid, which consists of several inactive oily acids, together with a powerfully vesicant substance named croton-resin,  $C_{19}H_{18}O_4$ , which is believed to be a lactone or inner anhydride of complicated structure. It is a hard, pale yellow, brittle substance, nearly insoluble in water, light petroleum, or benzene, but is readily dissolved by alcohol, ether, or chloroform. Though it has neither basic nor acid properties, the product of its oxidation by nitric acid is a mixture of acids. The vesicating power of the resin is destroyed by ebullition with alkalies, the products of the decomposition which takes place being several acids, some of which are members of the acetic series.

[Dose.— $\frac{1}{2}$  to 1 minim.

## Oleum Cubebæ.

**Oil of Cubebs** is obtained by distillation from cubeb fruits, which contain it—to the extent of 10 to 18 per cent.—in oil-cells in the pericarp and perisperm. Ammonia is given off during the course of the distillation, but the cause of its formation is no more understood in this case than when ginger, pepper, pimento, and other drugs are subjected to distillation. The rachis, stem, leaves, etc., also yield the oil, but in much smaller quantity, the rachis



containing less than 2 per cent. When freshly distilled, the oil is greenish or greenish-blue, but it tends to become yellowish on keeping. It can be obtained free from colour on redistillation, by rejecting the last portions of the distillate, which are blue, and therefore affect the colour of the oil if added to it.

**Characters.**—Oil of cubebs (specific gravity 0.910 to 0.930) may be colourless, pale green, or greenish-yellow, with the characteristic odour and camphoraceous taste of cubeb fruit. It is soluble in all proportions of absolute alcohol and in 18 parts of 90 per cent. alcohol.

**Notes.**—The greenish colour of oil of cubebs has been erroneously stated to be due to the presence of copper; it is really caused by the presence in greater or less quantity of the blue oil already referred to. The chief constituent of the oil is the sesquiterpene cadinene; other constituents are dipentene, lævo-pinene or lævo-camphene, and probably other terpenes or sesquiterpenes, together with a small quantity of cubeb camphor—a crystalline alcohol derived from the sesquiterpenes by oxidation and therefore more abundant in old samples of oil.

[Dose—5 to 20 minims.

## Oleum Eucalypti.

**Oil of Eucalyptus** is obtained by distillation from the fresh leaves of *Eucalyptus Globulus*, Labillardière (N.O. Myrtaceæ), and other species of *Eucalyptus*, which yields oil with a high cineol content. The oil is contained in numerous glands, situated in the mesophyll of the leaves. The fresh leaves of *E. Globulus* yield from 0.8 to 1.5 per cent. of oil, but those of other species may yield as much as 4 per cent.

**Characters and Tests.**—Oil of eucalyptus (specific gravity 0.919 to 0.930) is colourless or pale yellow, with an aromatic, camphoraceous odour, and a pungent taste which is followed by a sensation of coldness in the mouth. The oil is soluble in all proportions of absolute alcohol, in one-third its volume of 90 per cent. alcohol, and in thirty-eight parts of 60 per cent. alcohol. The peculiar taste and odour of the oil are chiefly due to cineol (eucalyptol), but the odour varies in accordance with the esters present. A high percentage of cineol is insured by the limitation of the specific gravity of the oil, as also by its optical activity being limited to 10 degrees in either direction. The presence of a due proportion of cineol is further provided for by the requirement that the oil should become semi-solid on being stirred, when cold, with one-third or one-half its volume of phosphoric acid (specific gravity 1.750); the cineol combines with the acid to form a crystalline compound, from which it is liberated in the pure state on adding hot water. The nitrite reaction serves to guard against the presence of more than small quantities of phellandrene, a terpene which constitutes the chief constituent of the oils of *E. amygdalina* and other species. If 2 C.c. of glacial acetic acid and 2 C.c. of a saturated aqueous solution of sodium nitrite be added to 1 C.c. of an oil containing but little phellandrene the mixture will remain liquid when gently stirred, but the presence of much phellandrene will cause the formation of a crystalline mass, consisting of phellandrene nitrite or nitrosite, the formation of which is the most characteristic property of phellandrene.

**Notes.**—The most important constituent of oil of eucalyptus is from 50 to 65 per cent. of cineol (eucalyptol), a body which also occurs in the oils of cajuput, wormseed, spike lavender, etc., and can be produced by treating terpin hydrate with dilute acids. It is an optically inactive, nearly colourless liquid (specific gravity 0.930), with a strong, aromatic, camphoraceous odour, a pungent, spicy, and cooling taste, and a refractive index of 1.4559; it solidifies at low temperatures, melts at  $-1^{\circ}\text{C.}$ , boils at  $176^{\circ}\text{C.}$ , and forms a crystalline phosphate when treated with phosphoric acid. Other constituents of oil of eucalyptus are dextro-pinene (eucalyptene) and other terpenes, as well as various aldehydes, alcohols, and esters.

[Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Juniperi.

**Oil of Juniper** should be obtained by distillation from the full-grown unripe green fruit or “berries” of *Juniperus communis*, Linné (N.O. Coniferae), but it is said to be chiefly obtained from the ripe fruit, and normal oil of ripe fruit is stated to be in all essential qualities superior. The thin outer skin of the fruit encloses a yellowish-brown, loose, soft tissue, in which are imbedded three hard, triangular seeds, which contain the oil in glands partly sunk in the hard tissue, while smaller and less conspicuous oil-glands are present in the pulp of the fruit. The ripe fruit yields from 0.5 to 1.5 per cent. of volatile oil, according to the district in which the plants are grown, Italian fruit yielding most and Swedish least.

**Characters and Tests.**—Oil of juniper (specific gravity 0.865 to 0.890) is colourless or pale greenish-yellow, with the characteristic odour of the fruit and a warm, aromatic, somewhat bitter taste. It dissolves, with slight turbidity, in four times its volume of a mixture of equal parts of absolute and 90 per cent. alcohols; it also mixes with an equal bulk of absolute alcohol, and dissolves in twenty parts of 90 per cent. alcohol, though the solution does not become quite clear. The solubility is less in the case of oil which has been kept.

**Notes.**—The age of the fruit from which oil of juniper has been distilled has a marked effect on the specific gravity of the oil, and that is also effected by keeping, since exposure to the air causes gradual resinification. The oil is always lævo-rotatory, but the rotation never exceeds  $-10^{\circ}$ . It contains the terpene pinene, a sesquiterpene (cadinene), an ester, and juniper camphor—a stearoptene or crystalline sesquiterpene alcohol.

[Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Lavandulæ.

**Oil of Lavender** is obtained by distillation from the flowers of *Lavandula vera*, De Candolle (N.O. Labiatae), the best oil being obtained from lavender grown in Surrey. The bulk of the oil yielded by the flowers is contained in glands on the calyx, from 1.5 to 3 per cent. being obtained when the flowers are distilled with water over an open fire, as soon as possible after being cut.

**Characters and Tests.**—Oil of lavender (specific gravity 0.885 to 0.890 or 0.900) is pale yellow or nearly colourless, with the fragrant odour of the flowers and a pungent, bitter taste. It should dissolve in all proportions of absolute or 90 per cent. alcohol, and in three times its volume of 70 per

cent. alcohol, the absence of oil of turpentine being thus indicated; the oil is also sparingly soluble in 60 per cent. alcohol.

**Notes.**—The usual adulterants of oil of lavender are the oils of spike and turpentine. The oil of spike (specific gravity 0.905 to 0.910), distilled from *Lavandula spica*, is much less fragrant than oil of lavender, its odour resembling that of a mixture of the oils of lavender and rosemary. Oil of turpentine (specific gravity 0.855 to 0.880) does not dissolve freely in 70 per cent. alcohol. Oil of lavender is lævo-rotatory, its optical rotation being from  $-5^{\circ}$  to  $-10^{\circ}$ ; its most important constituents are linalool and its acetic ester, linalyl acetate, which is also the characteristic ingredient of oil of bergamot. Since the ester is present in English oil of lavender to the extent of 7 to 10 per cent. only, whilst foreign oils yield as much as 28 to 40 per cent., the amount of ester cannot be regarded as an absolute standard for the quality of the oil. At the same time the fineness and the value of French oils appear to stand in direct ratio to the amount of linalyl acetate present. Other constituents of oil of lavender are pinene, limonene, geraniol and a sesquiterpene. Cineol is found in some quantity in English oil of lavender, but only traces of it exist in French oil. Oil of spike is dextro-rotatory ( $+1^{\circ}$  to  $+4^{\circ}$ ), and contains from 30 to 40 per cent. of alcohols—linalool, cineol, borneol, etc.—but only traces of esters, while camphor and other odorous substances are also present.

[Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Limonis.

**Oil of Lemon** is obtained from fresh lemon peel, being contained in numerous large oil-glands, imbedded in the tissue of the epicarp of the fruit. The greater part of the oil of commerce is produced in Sicily, chiefly in Messina and the adjacent districts, and in the province of Palermo. A large quantity is produced in Calabria, and exported from Reggio, whilst the North of Italy and South of France also supply the market with oil. It is obtained during the winter months, from November to March or April, that collected in November and December being usually of the finest quality. In the chief oil of lemon districts—Sicily and Calabria—the oil is collected by cutting the peel off the lemons in strips and then pressing it against a sponge in such a way that the oil glands are broken and the oil is forcibly ejected, the sponge being squeezed as it becomes saturated in order to remove the oil which has accumulated. In the North of Italy and the South of France the oil is collected by rotating the fruit rapidly in a tinned-copper saucer (*écuelle*), 20 to 25 Cm. in diameter, which is covered inside with short spikes, from 6 to 8 Mm. long; the oil-glands are broken by the spikes and the oil flows through a hole in the bottom of the saucer into a collecting tube beneath, which is periodically emptied. Machine processes are employed in some districts for extracting the oil, and simple distillation or expression in bags in ordinary presses may also be resorted to on occasion. In both the sponge and *écuelle* processes the residual traces of oil in the exhausted peel are extracted by placing the latter in hot water and skimming off the oil as it rises to the surface, or the peel may be subjected



to distillation; in either case the oil obtained is of inferior quality, its value being impaired by the heat employed in the process of extraction.

**Characters and Tests.**—Oil of lemon (specific gravity 0.857 to 0.860) is pale yellow, with the fragrant odour of the lemon, and a warm, somewhat bitter aromatic taste. It is soluble in 12 parts of 90 per cent. alcohol, and in all proportions of glacial acetic acid or absolute alcohol. The optical rotation of the oil at 20° C. should not be less than +59°, and the rotation may be as much as +66°. If, on submitting the oil to fractional distillation, the rotation of the first 10 per cent. collected differs by more than two degrees from that of the original oil, the presence of oil of turpentine may be indicated.

**Notes.**—The specific gravity of oil of lemon varies according to the period at which it is expressed, being higher towards the end of the season. The most common adulterant of the oil is oil of turpentine, which is much less soluble in alcohol and differs in its optical rotation. Turpentine will also distil over with the first 10 per cent. and affect the optical activity of that fraction. The pinene, of which oil of turpentine chiefly consists, boils at a much lower temperature than the terpenes of oil of lemon, and is lævo-rotatory or only slightly dextro-rotatory; it can also be detected by converting it into its crystalline hydrochloride—known as “artificial camphor”—by the action of hydrochloric acid gas. Waste terpenes, produced in the manufacture of “terpeneless” oil of lemon, have also been used as adulterants, but such additions reduce the proportion of the oxygenated constituents of the oil. The presence of alcohol can be detected by shaking the suspected oil with water, as it then diminishes in volume. Pure oil of lemon should evaporate from paper without leaving a stain, thus indicating the absence of fixed oil. The greater portion of oil of lemon (about 90 per cent.) consists of dextro-limonene and lævo-limonene, with traces of phellandrene and a sesquiterpene. But the characteristic odour of the oil is due to its oxygenated constituents, of which the aldehyde citral (geranial) is the most important. It occurs to the extent of 3.5 to 5 per cent. in pure oil of lemon, together with small quantities of citronellal, geranyl acetate, pinene, lævo-pinene, octyl aldehyde, nonyl aldehyde, methyl anthranilate, a resin, and—in the case of Palermo oil—linalyl acetate. As in the case of other essential oils obtained by expression, a more or less crystalline deposit of stearoptene is formed in oil of lemon on standing; the stearoptene possesses the characters of a lactone or inner anhydride and has been named citraptene. The oil also tends to change rapidly by the action of light and air, its colour changing and a thick, brown deposit separating, while the specific gravity and solubility of the oil increase, as in the case of oil of turpentine which has been long kept. [Dose.— $\frac{1}{2}$  to 3 minims.]

## Oleum Lini.

**Linseed Oil** is obtained by expression, at ordinary temperatures, from dried ripe linseed, which may contain as much as 30 to 40 per cent. When thus prepared by cold expression, the oil tends to become rancid on exposure, owing to the presence of much mucilage extracted from the seed; it is stated,

however, that the rancid oil may be rendered sweet again by agitation with warm water and subsequent decantation, after being allowed to rest awhile.

**Characters.**—Linseed oil (specific gravity, 0.930 to 0.940) is a viscid, yellow liquid, with a faint but distinct odour when fresh, and a bland taste. The odour and taste of the linseed oil of commerce are the result of exposure, or are due to the seed having been roasted before expression, in order to obtain the oil more free from mucilage; in the latter case the oil is highly coloured and acrid. The oil is officially stated to be soluble in 10 parts of 90 per cent. alcohol, but that statement is incorrect, as it is practically insoluble in 90 per cent. alcohol, though slightly soluble in absolute alcohol (1 in 40). It is miscible in all proportions with oil of turpentine, forming clear solutions, and is also soluble in ether, chloroform, or carbon disulphide, its solubility in the last-mentioned liquid affording a means of extracting the oil in a purer condition than usual, as well as in larger proportion. The absence of non-drying oils is indicated by the oil gradually thickening on exposure to air, a thin layer spread on glass forming a hard, transparent varnish. Linseed oil should not congeal above  $-20^{\circ}\text{C}$ .

**Notes.**—The specific gravity of linseed oil is very high, but it should probably not exceed 0.935. The oil consists chiefly of linolein, a mixture of the glycerides or glyceryl esters of linolic, linolenic, and isolinolenic acids, three isomeric bodies possessing similar physical characters, and sometimes described generally as linoleic acid. Other constituents of linseed oil are small quantities of olein, stearin, palmitin, and myristin—the glyceryl esters of oleic, stearic, palmitic, and myristic acids. The drying property of the oil is due to linolein, which does not produce a solid elaidin with nitrous acid as glyceryl oleate (olein) does. The varnish-like substance formed when linseed oil is exposed to the air, and known as “linoxyn,” is the result of the absorption of oxygen by linolein. Linseed oil is the best drying oil known, and possesses the highest iodine-absorption equivalent (178 per cent.) of all known fixed oils. The drying property of the oil is improved by boiling it with lead oxide or other “driers,” the metallic compound probably acting as a “carrier” of oxygen, and thus causing the more rapid conversion of linolein into linoxyn. The oil is heated to incipient decomposition during the process, and the resulting “boiled oil” contains some of the lead or other metallic oxide in solution.

## Oleum Menthæ Piperitæ.

**Oil of Peppermint** is officially directed to be obtained by distillation from the fresh, flowering peppermint, *Mentha piperita*, Smith (N.O. Labiateæ), a plant found growing wild throughout Europe and cultivated in England, France, Germany, and America. Two varieties, known as black and white peppermint respectively, are cultivated near Mitcham, preference being given to the former, which is more hardy and yields considerably more oil than the white variety, though the product is said to possess a less delicate aroma than that of white peppermint. The largest yield of oil is obtained from plants cut in September. In England the whole herb is distilled while fresh, the yield varying from about 0.5 to 1 per cent., but in America the plants are partially

dried before distillation, since experience has proved that a larger yield of oil can thus be obtained. At the same time, it should be noted that only the product of fresh plants is strictly in accordance with official requirements.

**Characters and Tests.**—Oil of peppermint (specific gravity, 0·900 to 0·920) is colourless, pale yellow or greenish-yellow when recently distilled, but it gradually becomes darker on keeping. It has the characteristic odour of the herb, and a strong, penetrating, aromatic taste, which is followed by a sensation of coldness in the mouth, owing to the presence of menthol. The oil should dissolve in four times its volume of 70 per cent. alcohol, with only a trifling opalescence at most; it mixes in all proportions with absolute alcohol, and is also soluble in half its volume of 90 per cent. alcohol, the solution becoming turbid on adding more of the solvent. On cooling the oil to  $-8^{\circ}$  C., a considerable separation of menthol should take place, if a few crystals of that substance be first added to start crystallisation. As a test for the menthol content of the oil this is unsatisfactory, on account of its purely qualitative character.

**Notes.**—The effects of climate, soil, and cultivation appear to have a marked influence on the quality and composition of peppermint oil. The chief constituent of the oil is menthol, but it may also contain esters, including menthyl acetate and isovalerate, together with menthone (a lactone with an odour somewhat like that of borneol), cineol, inactive pinene, lævo-limonene, cadinene, phellandrene, acetic aldehyde and acid, isovaleric aldehyde and acid, amyl alcohol, and dimethyl sulphide. Menthol behaves as an alcohol, and can be converted into the corresponding ketone, menthone, by oxidation, while menthone, in turn, can be converted into menthol by reduction. Part of the acid formed during the growth of the peppermint plant is believed to convert the alcohols present into esters, and so increase the fragrance of the oil, while another part acts as a dehydrating agent, converting alcohols into terpenes. American oil of peppermint contains less menthol than English oil, which contains from 60 to 70 per cent. German, French, Russian, and other oils of peppermint are known, but only those produced in Japan and China are of commercial importance. Japanese and Chinese oils from *M. arvensis*, DC., var. *piperascens et glabrata*, Holmes (specific gravity, 0·895 to 0·905) are the richest of all in menthol, sometimes containing as much as 85 per cent., and they are recognised officially as sources of that substance. It is stated that, as a rule, the oil of *M. piperita* can be distinguished from that of *M. arvensis* by the development of a blue colour and a red fluorescence when the oil is mixed with four times its volume of glacial acetic acid. The optical rotation of English or American oil from *M. piperita* is usually between  $-18^{\circ}$  and  $-33^{\circ}$ ; the rotation of Japanese oil is from  $-26^{\circ}$  to  $-42^{\circ}$ . Oil of peppermint from which part of the menthol has been separated by cooling is known as “dementholised” oil.

[Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Menthæ Viridis.

**Oil of Spearmint** is obtained by distillation from the fresh-flowering spearmint, *Mentha viridis*, Linné (N.O. Labiateæ), a native of Europe and Asia



which is cultivated for domestic use, as well as for the sake of its oil, of which the plant yields less than 0.5 per cent. of oil. Most of the oil in commerce comes from America, but English, German, and Russian oils are also known.

**Characters and Tests.**—Oil of spearmint (specific gravity, 0.920 to 0.940) is colourless, pale yellow, or greenish-yellow when recently distilled, but becomes darker on keeping. It has the characteristic odour and warm, slightly bitter taste of the spearmint, the taste being less pungent than that of peppermint. A clear solution should be obtained on mixing the oil with its own volume of a mixture of equal parts of absolute and 90 per cent. alcohols; the oil is also soluble in all proportions of absolute alcohol, and is stated by Squire to dissolve in about its own volume of 90 per cent. alcohol, the solution becoming milky on adding more of the solvent.

**Notes.**—Oil of spearmint may contain as much as 56 per cent. of carvone, together with lævo-limonene and lævo-pinene, while Russian oil of spearmint, which is said to be the product of *M. aquatica*, has been shown to contain carvone, linalool, cineol, and l-limonene. [Dose.— $\frac{1}{2}$  to 3 minims.]

## Oleum Morrhuæ.

**Cod-liver Oil** is extracted from the fresh liver of the cod, *Gadus Morrhua*, Linné (Order Teleostei), a fish which inhabits the Northern Atlantic Ocean. The oil is prepared in Norway, Newfoundland, etc., from fish caught on the coasts, unhealthy livers being rejected and the gall-bladders removed. By the application of low-pressure steam the oil is caused to separate from the livers at a temperature not exceeding 82° C., after which it is cooled to -5° C. and the frozen mass submitted to great pressure in canvas bags, the purified oil being forced through the canvas and a whitish tallow-like mass of so-called "stearine" and liver débris left in the bags. The product is known as "non-freezing" oil, because it does not readily become turbid when subjected to low temperatures. The oil may also be extracted by heating the livers in a clean iron pot over a slow fire, stirring them until they are in a pulpy condition, at a temperature not exceeding 89° C., and subsequently straining the pulpy mass through canvas, after which the oil is separated from the water present and filtered through paper; or, the livers may be simply heated with water and the separated oil subsequently strained. Inferior, brownish oil is obtained by allowing livers to undergo gradual decomposition in barrels.

**Characters and Tests.**—Cod-liver oil (specific gravity, 0.920 to 0.930) should be of a pale yellow colour, with a slight fishy but not rancid odour, and a bland, slightly fishy taste. It is readily soluble in ether (1 in 2) or chloroform, and slightly soluble in absolute or 90 per cent. alcohol. On adding a drop of sulphuric acid (specific gravity, 1.843) to a few drops of cod-liver oil on a porcelain slab, a violet coloration is produced, the presence of cholesterin being thus indicated and affording a distinction from seal oil or vegetable oils. Cod-liver oil should be only slightly acid and, as upon the acidity also depends the presence or absence of albumin—fine oils with little acid showing an albumin ring when floated upon nitric acid—absence of excess of free fatty acids is shown by the separation of albumin on adding nitric acid (specific gravity, 1.42)

to the oil, a precipitate of coagulated albumin being formed at the point of contact of the two liquids. Freedom from other fish oils and certain vegetable oils is proved by no solid fat separating on cooling the oil to  $0^{\circ}$  C. for two hours.

**Notes.**—Inferior or old samples of cod-liver oil are liable to be dark coloured, acrid or bitter, unduly acid, and more or less rancid. There may be no trace of acidity in fine colourless oil, though as much as 9 per cent. of free acid has been found in dark coloured samples, altered by heat and long keeping. It was formerly supposed that the chief constituents of cod-liver oil were about 70 per cent. of glyceryl oleate (olein), 25 per cent. of glyceryl palmitate (palmitin), and some glyceryl stearate (stearin), but it is now understood that the oil contains but little olein, palmitin, or stearin, the chief constituents being jecolein and therapin—glycerides of jecoleic acid,  $C_{19}H_{36}O_2$ , and therapeutic acid,  $C_{17}H_{34}O_2$ , respectively—together with glycerides of one or more unknown acids, and traces of cholesterol (cholesterin), alkaloidal bodies (aselline, morrhaine, etc.), bile acids, and iodine, while the glycerides of acetic, butyric, valeric, and capric acids sometimes occur as secondary products, owing to putrefaction of the livers employed. Jecoleic acid is described as a very unstable compound, belonging to the same series as oleic acid and probably isomeric with doeglic acid. On distillation with ammonia, the oil yields trimethylamine, being thus distinguished from other official fixed oils. Oils from the livers of other species of *Gadus* have analogous properties to cod-liver oil, and are difficult to detect when mixed with it, the odour and taste being the most reliable tests. Seal oil has also been used as an adulterant of cod-liver oil, but it contains no cholesterol, and may be distinguished by the sulphuric acid test.

[Dose.—1 to 4 fluid drachms.

## Oleum Myristicæ.

**Oil of Nutmeg** is obtained by distillation, nutmegs yielding from 8 to 15 per cent. of volatile oil when the seeds are powdered and distilled with water, or the powder may be exhausted by means of carbon disulphide or ether. A similar oil, which is more fragrant and much more expensive, is obtained by distillation from mace, the dried arillus of the nutmeg, which yields from 4 to 15 per cent.

**Characters and Tests.**—Oil of nutmeg (specific gravity, 0.870 to 0.910) is colourless or pale yellow, and possesses the characteristic odour and taste of nutmeg. The oil mixes in all proportions with absolute alcohol and is soluble in 4.5 parts of 90 per cent. alcohol, but only sparingly soluble in 60 per cent. alcohol. It should form a clear solution when mixed with its own volume of a mixture of equal parts of absolute and 90 per cent. alcohols; on evaporating a little of this alcoholic solution on a water-bath and then cooling, there should be no crystalline residue of myristic acid left, thus showing the absence of concrete or fixed oil of nutmeg, which is sometimes carried over mechanically during the process of distillation.

**Notes.**—The specific gravity of oil of nutmeg may vary much more than is officially recognised, the limits being from 0.865 to 0.920; the specific gravity of the volatile oil of mace is from 0.890 to 0.930. The optical rotation of oil

of nutmeg is from  $+14^{\circ}$  to  $+28^{\circ}$ ; that of oil of mace is from  $+10^{\circ}$  to  $+20^{\circ}$ . Oil of nutmeg appears to vary considerably in composition, but Ceylon oil has been shown to contain about 80 per cent. of dextro-camphene, 8 per cent. of dipentene, 6 per cent. of geraniol, 4 per cent. of myristicin, dextro-pinene, eugenol, isoeugenol, dextro-linalool, dextro-borneol, iso-terpineol, safrol, myristic acid, an alcohol yielding a di-ketone, an aldehyde resembling citral, and small amounts of various acids—formic, butyric, octoic, etc., in the form of esters. The expressed oil of nutmeg, which contains about 5 per cent. of the volatile oil, together with free myristic acid and glyceryl myristate (myristin) and stearate, separates from an alcoholic solution in extremely light crystalline scales, and its presence is said to be objectionable when the volatile oil is used for flavouring aromatic spirit of ammonia. The volatile oil of mace contains dextro-pinene, lævo-pinene, dipentene, myristicol (a mixture of terpeneol and other alcohols), a phenol, and myristicin. [Dose.— $\frac{1}{2}$  to 3 minims.]

## Oleum Olivæ.

**Olive Oil** is obtained by expression from the pericarp of the ripe fruit of *Olea europæa*, Linné (N.O. Oleaceæ), a small tree cultivated in Spain, France, Italy, and other countries bordering on the Mediterranean, also in California. The ordinary olive of commerce is picked before ripening, and its taste differs considerably from that of the ripe olive, which may contain as much as 50 per cent. of oil. The fruit ripens from November to March, and is then collected, bruised in a mill, and submitted to pressure. The best or "virgin" oil is obtained from fruit picked before perfect maturity, and immediately subjected to moderate pressure. It is distinguished by its greenish hue, due to the presence of chlorophyll. The residual pulp yields more oil on being thrown into boiling water, the oil separating and rising to the surface. The finest ordinary oil is obtained by crushing and pressing the fruit when it is quite ripe, removing colouring matter and other impurities from the oil by allowing it to flow into water, and subsequently separating the oil from the water by skimming. By mixing the marc with hot water and again pressing, a further yield of oil may be obtained, but that is of inferior quality, while oil of a very inferior kind is obtained by allowing the residue to ferment, and pressing it a third or even a fourth time; or, the entire fruit may be thrown into heaps and allowed to ferment for several days before pressure.

**Characters and Tests.**—Olive oil (specific gravity, 0.914 to 0.919) should be pale yellow or greenish-yellow, with a faint odour and a bland taste. It is soluble in chloroform, carbon disulphide, or ether, but is only partially soluble in 90 per cent. alcohol. It is liable to deposit solid fats and assume a pasty consistence when cooled to  $10^{\circ}$  C., and forms a nearly solid, granular mass at  $0^{\circ}$  C., the actual congealing point depending largely upon the length of time the oil is exposed to cold. Thus, oil cooled to a very low temperature for a brief time may remain unchanged, whereas the same oil will become partially solidified if kept at a somewhat higher temperature for several hours. Olive oil which does not congeal is the product of over-ripe fruits. The presence of cotton-seed oil, which is a common adulterant of olive oil, can be detected,



except when the cotton-seed oil has been previously heated or highly purified, by Becchi's test, which should be applied exactly as described. It will be seen that the description differs somewhat from that of the same test, as given under "Adeps" (*vide* page 44). The blackening is due to the reduction of the silver salt by some constituent of the cotton-seed oil. A more satisfactory test is that of Bevan (*vide* page 45).

**Notes.**—The greenish tinge possessed by the finest olive oil is due to the presence of chlorophyll, and a similar tinge is sometimes imparted artificially to inferior oils. In the unripe olive mannite and a peculiar green substance have been found, but they both disappear as the fruit ripens, being probably converted into oil. The chief constituents of olive oil are the glycerides of oleic and linolic acids, which may be present to the extent of 72 per cent., and do not congeal when the oil is cooled. About 93 per cent. of the liquid glycerides consists of olein (glyceryl oleate) and 7 per cent. consists of the glyceride of linolic acid. The part of the oil which congeals on cooling consists chiefly of palmitin and arachin, the glycerides of palmitic and arachidic acids. Olive oil contains no stearin, but phytosterol and free fatty acid are usually present in small quantity in the oil, and the proportion of free acid is very great in the case of inferior, old, or rancid oil. When exposed to the air olive oil is apt to lose colour and become rancid, acquiring a disagreeable smell, a sharp taste, and a thicker consistence; the change is promoted by heat, and is accompanied by a large increase in the quantity of fatty acid present in the oil. The proportion of acid may be determined by titration with alcoholic potassium hydroxide in ether-alcohol solution. On treatment with nitrous acid or with an acid solution of mercuric nitrate—as in making Unguentum Hydrargyri Nitratis—the olein of olive oil is converted into the solid isomeric substance—eläidin (*vide* Notes on Acidum Oleicum, page 28). In addition to cotton-seed oil, olive oil may be adulterated with earth-nut, sesame, poppy, and other oils. Cotton-seed oil can be detected by Becchi's or Bevan's test; the other oils generally used as adulterants are less readily congealed than olive oil. Further tests of purity are afforded by the specific gravity of olive oil, which is very constant, and the quantity of iodine—from 79 to 88 per cent.—which the oil is capable of absorbing.

## Oleum Phosphoratum.

**Phosphorated Oil** is a solution of dry phosphorus in almond oil which has been freed from any trace of air or water by the application of heat, so as to prevent oxidation of the phosphorus. The oil is heated in a porcelain dish to about 150° C., and kept at that temperature for about fifteen minutes, then allowed to cool and filtered through paper. To make 100 parts of phosphorated oil, 99 parts by weight of the prepared almond oil should be placed in a bottle capable of containing rather more than that quantity, and 1 part of dry phosphorus must then be added and the bottle closed with a stopper. Solution is effected by immersing the bottle in hot water until the temperature of the contents is about 80° C., the stopper being removed from time to time to allow the expanded air to escape, and the bottle shaken at intervals until the phosphorus is entirely dissolved.

**Characters.**—Phosphorated oil is a clear, straw-coloured liquid, which phosphoresces in the dark and possesses the distinctive odour and taste of phosphorus, of which it must contain 1 per cent. by weight.

**Notes.**—It is essential that phosphorated oil should be recently prepared, and kept in a cool place, protected from the light, as, if kept some time or exposed unduly, oxidation of the phosphorus takes place, an inactive red precipitate being formed and the preparation becoming weak in phosphorus. An emulsion of the oil may be prepared by using 5 parts each of powdered gum acacia and sugar for each 10 parts of oil and adding 80 parts of water. To cover the disagreeable taste of the phosphorus the emulsion may be flavoured with essential oil of bitter almond.

[Dose.—1 to 5 minims.

## Oleum Pimentæ.

**Oil of Pimento** is prepared by distillation from the dried full-grown unripe fruit, which contains from 3 to 4·5 per cent., the oil being contained in a large number of oil-glands imbedded in the thin pericarp and in others present in the seeds.

**Characters and Test.**—Oil of pimento (specific gravity from 1·040 to 1·055) is yellow or yellowish-red when recently distilled, but gradually becomes darker on keeping. It has the odour and taste of pimento fruit, is soluble in all proportions of 90 per cent. alcohol and in 50 parts of 60 per cent. alcohol. On shaking the oil with an equal volume of strong solution of ammonia (specific gravity, 0·891), it should be converted into a semi-solid mass of eugenol-ammonium. The eugenol present also causes an alcoholic solution of the oil to yield a blue colour with a 5 per cent. solution of ferric chloride, as in the case of oil of cloves, the chemical constitution of which closely resembles that of oil of pimento.

**Notes.**—The odour of oil of pimento somewhat recalls those of cloves, cinnamon, nutmeg, and pepper, that of cloves predominating. The oil contains 65 per cent. or more of eugenol, together with cineol, phellandrene, caryophyllene, methyl-eugenol, and palmitic acid, while a certain amount of resin, formed by oxidation of some of the less stable constituents of the oil, is usually present. If the specific gravity of the oil be lower than 1·040, it may be assumed that some of the eugenol has been removed, or that the oil has been adulterated with substances having a lower specific gravity.

[Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Pini.

**Oil of Pine** is obtained by distillation from the fresh leaves of the Mountain Pine, *Pinus Pumilio*, Haenke (N.O. Coniferæ), a small tree found in the sub-alpine regions of Central Europe and also in the Carpathian mountains.

**Characters and Tests.**—Oil of pine (specific gravity, 0·865 to 0·870) is colourless, or nearly so, with a pleasant aromatic odour and a pungent taste. It should rotate the plane of a ray of polarised light from 5 to 10 degrees to the left, and not more than 10 per cent. of the oil should distil below 165° C., the absence of oil of turpentine being thus indicated, since pinene, the chief constituent of oil of turpentine, boils at 156° C.

**Notes.**—The oil of *Pinus sylvestris* has a specific gravity of not less than 0.880, and it may rotate the plane of polarisation about 20 degrees to the right or left. Other pine-needle oils are of still higher specific gravity, and their optical rotation differs widely from that of the official oil of pine. The latter resinifies on exposure; it contains from 5 to 7 per cent. of bornyl acetate, to which the odour of the oil is chiefly due, together with l-pinene, l-phellandrene, sylvestrene, cadinene, and dipentene. Bornyl acetate is the only fatty acid ester of borneol that will crystallise. Borneol, also known as Borneo camphor, is closely related to ordinary official camphor. Camphor is a ketone, probably belonging to the hexamethylene group, and borneol is the corresponding alcohol. Hence, for the same reason as in the case of menthol, borneol easily forms esters, and does not behave like a phenol.

## Oleum Ricini.

**Castor Oil** is obtained by expression from the seeds of *Ricinus communis*, Linné (N.O. Euphorbiaceæ). When fresh, the seeds have an almost imperceptible odour and a sweetish, very slightly acrid taste, but they easily become rancid and unfit for the extraction of oil for medicinal purposes. They contain about 50 per cent. of fixed oil, which is usually extracted by cold pressure, without any previous treatment, and subsequently filtered. It may be bleached by exposure to sunlight, but is sometimes bleached by chemical means, and may then contain traces of sulphonc compounds. In Italy, the seed-coats are removed before expression, and hot iron plates are used to promote the flow of oil; in America, the seeds are gently heated in the first place and the oily liquid obtained on expression is boiled with water to remove mucilage, starch, and albumin. A process of extraction by means of alcohol has been practised in France, but the oil so obtained is said to become rancid more quickly than expressed oil. Large quantities of oil are also produced in India, by roasting, pounding, and boiling the seeds with water, but such oil is not suitable for medicinal purposes.

**Characters and Tests.**—Castor oil (specific gravity, 0.950 to 0.970) is a viscid liquid which should be colourless or have only a faint yellow tint, and be almost destitute of odour; the taste is at first bland, but subsequently acrid and unpleasant. The oil is soluble in an equal volume of absolute alcohol, and in five times its volume of 90 per cent. alcohol; it is also entirely soluble in all proportions of ether, oil of turpentine, or glacial acetic acid, but insoluble in petroleum spirit. The oil absorbs about 83 per cent. its weight of iodine. It dries slowly to a varnish-like film when exposed to the air in a thin layer, and should not become brown when shaken with an equal volume of carbon bisulphide and one-third its volume of sulphuric acid, the absence of cotton-seed and other fixed oils being thus indicated. An additional test for the presence of other fixed oils is based on the fact that pure castor oil does not yield a clear mixture at 15.5° C., when mixed with its own volume of petroleum spirit; but a perfectly clear solution may be formed if the oil be adulterated with other fixed oils.



**Notes.**—The distinctive characters of castor oil are its high specific gravity and viscosity and its behaviour with solvents. There is some doubt as to the value of the carbon bisulphide and sulphuric acid test, some observers stating that genuine castor oil gives a brown or yellowish brown colour under the conditions prescribed. The behaviour of the oil towards petroleum spirit is very peculiar among the fixed oils, since—with the exception of castor oil—they all dissolve in almost any proportion in that spirit. The presence of a comparatively small quantity of foreign oil in castor oil is, however, sufficient to cause the oil so adulterated to form a clear mixture with the same solvent. Castor oil does not readily congeal when cooled; when exposed to air it slowly thickens without becoming opaque, and may become rancid. It is heavier than most other fixed oils, and differs from them in being soluble in all proportions of cold absolute alcohol. It also has the property of rendering a portion of other fixed oils soluble in alcohol. Castor oil with a distinct yellowish or brownish colour usually has an unpleasant odour, and a hot, acrid taste. The chief constituent of the oil is ricinolein, a mixture of the glycerides of ricinoleic (ricinolic) acid and isoricinoleic acid; a glyceride of stearic acid is also present in small quantity, but olein and palmitin are absent. Ricinoleic acid ( $C_{18}H_{34}O_3$ ) contains one atom of oxygen more than oleic acid, but, like that acid, absorbs two atoms of iodine per molecule; it is a viscid oil and yields ricinelaïdic acid, a crystalline body, when acted upon by nitrous acid; similarly, when castor oil is treated with nitrous acid, the ricinolein is converted into ricinelaïdin. By the action of potassium hydroxide, ricinoleic acid is converted into sebacic acid and caprylic alcohol, with disengagement of hydrogen. From a study of its reactions, ricinoleic acid is believed to be a hydroxyl derivative of oleic acid, and the formula may be written  $C_{17}H_{32}(OH) \cdot COOH$ . That it belongs to the unsaturated oleic series is shown by its iodine absorption, and the presence of one alcoholic hydroxyl group is demonstrated by the acetylation which it undergoes when treated with acetic anhydride. Ricinone, a purgative substance, and ricin, a poisonous albumose, have been obtained from the cake left after castor oil has been extracted from the seeds by expression.

[Dose.—1 to 8 fluid drachms.

## Oleum Rosæ.

**Oil of Rose**, commonly known as Otto of Rose, is obtained by distillation from the fresh flowers of *Rosa damascena*, Miller (N.O. Rosaceæ), a plant which is unknown in the wild state, but is largely cultivated in European Turkey, Egypt, Persia, Cashmere, India, and other Eastern countries, for the sake of the oil, together with other species—including *R. sempervirens*, *R. moschata*, and *R. centifolia*. The process of distillation varies in different districts; in the most important rose district, that of Kizanlik, on the southern slope of the Balkans, the flowers are gathered in May, in the early morning, before they commence to open, and distilled with water over an open fire. The oil collects on the surface of the water in the receiver, and is removed from time to time as it accumulates. The average yield of oil is about 1 kilo. from 3,000 kilos. of rose petals.

**Characters and Test.**—Oil of rose (specific gravity, 0·856 to 0·860 at 30° C.) is a pale-yellow, crystalline semi-solid, with the strong fragrant odour of the damask rose, and a sweet taste. As the value of the oil is largely affected by the amount of crystalline matter present, its congealing and melting points—from 19° to 22° C.—are of importance.

**Notes.**—Palmarosa or East Indian geranium oil, from *Andropogon Schœnanthus*, is a common adulterant of oil of rose. It lowers the melting point, but that effect is counteracted by the addition of spermaceti, stearin, paraffin wax, or the oil of *Rosa alba*, which contains more solid stearoptene than that of *R. damascena*. An oil obtained from the wood of *Bulnesia sarmienti*—"guaiacum wood" oil (specific gravity, 0·970 at 30° C.)—has also been used as an adulterant of oil of rose; it has a pleasant, violet-like odour, solidifies with a crystalline structure at ordinary temperatures, and liquefies at 40° to 50° C., but rapidly solidifies again on cooling. The chief constituents of oil of rose are geraniol and citronellol, the former constituting three-fourths of the liquid portion of the oil, and citronellol the remaining fourth. They are both alcohols of the olefinic or unsaturated aliphatic series. The odour of the oil is entirely due to those alcohols and their esters, traces of which are also present. Free acids resulting from decomposition of the esters also occur in the oil, and rose water is frequently slightly acid in consequence. The solid stearoptene—a mixture of paraffin hydrocarbons—is odourless; it crystallises out at about 20° C. The presence of spermaceti and stearin in oil of rose will be indicated on saponification, the resulting salts yielding palmitic and stearic acids respectively when decomposed with hydrochloric acid; no fatty acids are yielded on saponification of pure oil of rose. Added paraffin crystallises with a more granular structure than the normal stearoptene of oil of rose. The solid portion of "guaiacum wood" oil consists of an odourless alcohol—guaiol—which can be acetylated, thus differing from the normal stearoptene of oil of rose. Oil of santal and other volatile oils used as adulterants of oil of rose are not semi-solid like the latter; fixed oils leave a greasy stain on paper when heated.

## Oleum Rosmarini.

**Oil of Rosemary** is obtained by distillation from the flowering tops of *Rosmarinus officinalis*, Linné (N.O. Labiata). A strong balsamic odour is possessed by all parts of the plant, but chiefly by the leaves, which have a bitter camphoraceous taste, owing to the presence of volatile oil in the glands they bear. The oil is chiefly produced in the South of France and in the Dalmatian Islands (Italian rosemary oil), but a certain quantity is also produced in England. The plants are subjected to distillation as quickly as possible after being cut, the flowering tops only being used, as the woody parts of the plants impart an objectionable odour to the oil. English oil is the finest and French ranks next in value, Italian being least valuable.

**Characters and Tests.**—Oil of rosemary (specific gravity, 0·900 to 0·915) is colourless or pale yellow, with the odour of the plant and a warm, camphoraceous taste. It should dissolve in twice its volume of 90 per cent. alcohol,

and may dissolve in as little as half its volume; it is also soluble in all proportions of absolute alcohol, but only sparingly soluble in 60 per cent. alcohol. The absence of turpentine is proved by the optical rotation of the oil not exceeding  $10^{\circ}$  to the right.

**Notes.**—The chief adulterants of oil of rosemary—turpentine and petroleum—are much less soluble than the oil in 90 per cent. alcohol. Petroleum will also be left unvolatilised on evaporating oil containing it on a water-bath, whereas pure oil of rosemary will leave only a slight resinous residue. Added alcohol may be detected by drying the oil over calcium chloride and adding a crystal of magenta, which will dissolve and colour the oil pink if alcohol be present, though insoluble in pure oil. The chief constituents of oil of rosemary are about 6 per cent. of borneol, and 17 to 20 per cent. of bornyl acetate and other esters of borneol; the oil also contains camphor, cineol, pinene, and camphene.

[Dose.— $\frac{1}{2}$  to 3 minims.]

## Oleum Santali.

**Oil of Sandal or Santal Wood** is obtained by distillation from the wood of *Santalum album*, Linné (N.O. Santalaceæ), a small tree cultivated in Southern India for the sake of its wood and the oil it yields. After the trees have been uprooted and deprived of their bark and part of the sapwood, the trunks are sawn into pieces about 1 metre in length and trimmed, the roots being also freed from bark. The logs—consisting of the heartwood only—are then exported to London, where most of the oil is distilled, the wood being rasped as fine as possible by special machinery and distilled with high-pressure steam. The volatile oil is found in all the elements of the wood, the yield varying from 1.5 to 6 per cent. It is known in commerce as East Indian sandal wood oil. Some oil is produced in Mysore by distillation over an open fire, but it is of very inferior quality.

**Characters and Tests.**—Oil of sandal wood (specific gravity, 0.975 to 0.980) is somewhat viscid in consistence and pale yellow in colour, with a strongly aromatic odour and a pungent, spicy taste. It is soluble in less than its own weight of 90 per cent. alcohol and—except in the case of old or badly-preserved specimens—should form a clear solution with six times its volume of 70 per cent alcohol, the absence of cedar wood oil, and possibly of other oils, being thus indicated. The high boiling point of sandal wood oil is characteristic; at 14 Mm. pressure nothing should distil under  $150^{\circ}$  C., but 80 to 90 per cent. of cedar wood oil passes over below that temperature. The absence of other varieties of sandal wood oil is indicated by the optical rotation being not less than  $-16^{\circ}$  and not more than  $-20^{\circ}$ .

**Notes.**—In addition to cedar wood oil and varieties of sandal wood oil, castor oil, gurjun oil, copaiba oil, etc., may be present as adulterants, but the specific gravity, solubility in alcohol, and polarisation test serve in most cases to detect the adulteration. East Indian sandal wood oil consists of 94 to 98 per cent. of santalol—a mixture of two sesquiterpene alcohols with different boiling points—together with esters, free acid, and the aldehyde santalal. West Australian sandal wood oil (specific gravity, 0.963 to 0.965), from *Santalum cygnorum*,



contains only about 75 per cent. of santalol. The so-called West Indian sandal wood oil (specific gravity, 0.953 to 0.966), from *Amyris balsamifera*, is dextro-rotatory, and does not contain more than 30 to 50 per cent. of alcohol—amyrol. The oil of *S. preissianum* (specific gravity, 1.02), a South Australian tree, is quite different from ordinary sandal wood oil; it becomes solid when cooled, and yields a solid alcoholic constituent and crystalline esters. African sandal wood oil (specific gravity, 0.965) is of unknown origin, but somewhat resembles the West Indian oil; Fiji sandal wood, the product of *S. yasi*, yields 6.25 per cent. of oil (specific gravity, 0.977). [Dose.—5 to 30 minims.]

## Oleum Sinapis Volatile.

**Volatile Oil of Mustard** is obtained by distillation from dried, ripe black mustard seeds, after they have been deprived of fixed oil and macerated with water to allow of the interaction of the two substances which yield the oil. The seeds contain the crystalline glucoside sinigrin (potassium myronate) and the ferment myrosin in separate cells. In the presence of water the ferment is enabled to act upon the glucoside, causing its decomposition into allyl isothiocyanate (thiocarbimide or isosulphocyanide), potassium acid sulphate, and glucose, thus—

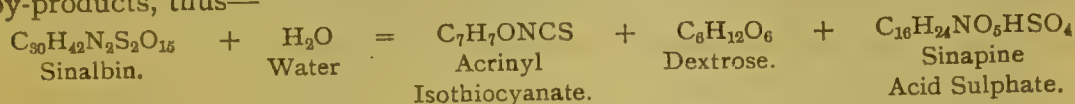


The allyl isothiocyanate is accompanied by a small quantity of normal allyl thiocyanate, together with traces of cyanallyl and carbon disulphide, but the volatile oil of mustard, of which the seeds yield from 0.5 to 0.75 per cent., may be regarded as consisting essentially of allyl isothiocyanate. After the fixed oil of mustard has been expressed from the seeds by means of hydraulic presses, the residual cake is macerated in tepid water for several hours to allow fermentation to take place, and then distilled with water vapour.

**Characters and Tests.**—Volatile oil of mustard (specific gravity, 1.018 to 1.030) is colourless or pale yellow, with an intensely penetrating odour and a very acrid taste. It contains from 95 to 99 per cent. of allyl isothiocyanate, to which the high specific gravity of the oil is due. Applied to the skin, it produces almost immediate vesication. The oil distils between 147° and 152° C., and the absence of ethylic alcohol or petroleum is proved by the first and last portions of the distillate having the same specific gravity as the original oil.

**Notes.**—The specific gravity test serves to indicate the absence of chloroform, carbon disulphide, or fatty oils, as well as of alcohol and petroleum; the absence of phenols may be shown by the non-production of a blue or violet colour when a small portion of the oil is diluted with five times its volume of alcohol, and a drop of 10 per cent. ferric chloride solution is added. The oil, as already stated, consists almost entirely of allyl isothiocyanate, but it also contains small amounts of allyl cyanide, carbon disulphide, and the isomeric allyl thiocyanate. Allyl isothiocyanate can be produced artificially by distilling allyl iodide or bromide with an alcoholic solution of potassium

thiocyanate. Allyl thiocyanate is first formed, but is readily changed into its isomer by heating it to its boiling point,  $161^{\circ}$  C. If mustard seeds be heated to above  $70^{\circ}$  C. they yield no volatile oil on subsequent distillation with water, as the myrosin—an albuminous compound—coagulates at  $60^{\circ}$  C. and then becomes inactive. White mustard seeds contain a crystalline glucoside, sinalbin, which is hydrolysed by myrosin, acrinyl, isothiocyanate or thiocarbimide being formed, while glucose and sinapine sulphate are produced as by-products, thus—



Acrinyl isothiocyanate, or oil of white mustard, is a yellowish oily liquid, of pungent odour when heated, though possessing only a faint anise-like odour when cold. It is soluble in dilute alkalies and possesses rubefacient and vesicating properties, somewhat like those of allyl isothiocyanate. It is, however, only sparingly volatile with water vapour, and thus differs essentially from the volatile oil obtained from black mustard seeds, as it cannot be prepared from the seeds by distillation. Sinapine is a base which is known only in combination or in solution; it is said to exist in white mustard seeds as thiocyanate, in addition to being formed by the action of myrosin on sinalbin.

## Oleum Terebinthinæ.

**Oil of Turpentine** is obtained by distillation from the viscid oleo-resin or crude turpentine which exudes from the wood of *Pinus sylvestris*, Linné (N.O. Coniferæ), and other species of *Pinus*, which grow in America, France, Germany, Russia, and elsewhere, distillation being effected chiefly by the aid of steam, and the product rectified by redistillation if necessary. The oleo-resin is contained in a branching system of schizogenous secretion ducts in the wood and exudes when the ducts are punctured, being collected in cavities cut in the trunks of the trees near their base. In order to start the flow of turpentine, the trees are deprived of their bark and part of the young wood to the height of about a metre, and triangular incisions are made in the older wood; from those incisions the oleo-resin flows into the cavities, further strips of bark being removed and fresh incisions made in the wood, from time to time, so as to increase the flow. The last portions of the exuded oleo-resin suffer loss of oil by evaporation and form a yellowish-white incrustation on the wounded surface of the tree in the autumn; that is removed by scraping and constitutes the article known in commerce as “gum thus” or “American frankincense.” The crude turpentine is removed from the cavities in which it collects and conveyed in barrels to copper stills set in brick furnaces. After being placed in the stills water is added and heat applied; chips of wood and other mechanical impurities which float to the surface are then skimmed off, and distillation is allowed to proceed. The oil of turpentine passes over with the water, from which it is subsequently separated, and the resin (colophony) remains in the stills. Though about 20 per cent. of oil is yielded by the crude turpentine obtained from the trees the first year, the



proportion of oil diminishes and that of resin increases year by year, very little oil being obtained after five or six years, while the resin is then very dark in colour and of inferior quality. Since oil of turpentine absorbs oxygen when exposed to the air, becoming thicker and yellowish, owing to the formation of resin, it usually requires to be rectified by redistillation with water when intended for medicinal purposes. Purification of the oil may also be effected by means of lime water or a solution of potassium hydroxide, any free acid being thus neutralised and removed, or the resinified portion of the oil may be removed by agitation with alcohol and water, alternately.

**Characters and Tests.**—Oil of turpentine (specific gravity, 0·855 to 0·880) should be limpid and colourless, with a strong peculiar odour which varies in the different kinds of oil, and a pungent, somewhat bitter taste. It is soluble in all proportions of absolute alcohol, and in 6·5 parts of 90 per cent. alcohol, and is miscible with 99·5 per cent. glacial acetic acid in all proportions, but does not form a clear mixture with an equal volume of the 99 per cent. acid. The oil commences to boil below 160° C., and should distil almost entirely below 180° C., little or no residue remaining. From 75 to 80 per cent. passes over between 155° and 162° C., the mercury rising rapidly above the latter point and a soft colophony-like resin being left in the still.

**Notes.**—Petroleum spirit, resin spirit, and the volatile portions of shale oil and coal tar have been used as adulterants of oil of turpentine, but the temperature of distillation rises gradually in the case of an oil so adulterated, and, if the adulteration be at all excessive, no large fractions are obtained at any definite temperature. The absence of petroleum, paraffin oils, or resin is shown by the oil leaving only a very slight residue when evaporated on a water-bath. Ordinary petroleum spirit lowers the flash point of oil of turpentine, as little as 1 per cent. of the adulterant lowering the flash point by about six degrees Centigrade. There are many varieties of oil of turpentine, but the American and French oils are the only kinds of commercial importance. American oil (specific gravity, 0·858 to 0·877) is the kind most commonly used in this country; it is mainly the product of *P. australis* and *P. Tæda*; and is almost invariably dextro-rotatory (+10° to +15°), though it may be slightly lævo-rotatory, as it contains both dextro- and lævo-rotatory terpenes, and the latter is sometimes in excess. French oil (specific gravity, 0·859 to 0·876) is chiefly obtained from *P. maritima* or *P. pinaster*, and is always strongly lævo-rotatory (−18° to −40°). Whatever may be the source of oil of turpentine, it consists of hydrocarbons,  $C_{10}H_{16}$ , the chief of which are the two isomeric bodies—dextro-pinene and lævo-pinene. It may also contain, as oxidation products, traces of formic, acetic, and camphoric acids, as well as camphoric aldehyde, to the presence of which the peculiar odour of “rancid” turpentine is probably due. Other constituents of the oil are resin acids, camphene, and fenchene, whilst dipentene—the optically inactive form of limonene—and polymeric terpenes also occur, presumably as the result of the action of the acids present on pinene. American oil consists chiefly of dextro-pinene, with some lævo-camphene, fenchene, and a little dipentene. French oil of turpentine is very similar in composition to American oil, but consists chiefly of lævo-pinene. By the action of hydrochloric acid gas, pinene is con-



verted into a crystalline substance (melting point,  $125^{\circ}$  C.) known as artificial camphor, the hydrochloride prepared from dextro-pinene being optically inactive, whilst that from lævo-pinene is strongly lævo-rotatory. The action of direct sunlight on oil of turpentine, in the presence of moisture and air or oxygen, causes the formation of pinol hydrate, while if exposed to the continuous action of air, in the presence of water, the oil develops a large quantity of oxygenated products, including hydrogen peroxide and camphoric acid, "Sanitas" being thus produced, by passing air through Russian oil of turpentine in contact with warm water. Again, by treatment with sulphuric acid, oil of turpentine yields terebene—a mixture of dipentene, terpinene, and other optically inactive terpenes.

[Dose.—2 to 10 minims; as an anthelmintic, 3 to 4 fluid drachms.

## Oleum Theobromatis.

**Oil of Theobroma or Cacao Butter** is a concrete oil obtained by expression from the warm crushed seeds of *Theobroma Cacao*, Linné (N.O. Sterculiaceæ). The seeds contain about 46 per cent. of the solid fat or fixed oil, which can be extracted from the crushed seeds, moistened with water, by expression between hot, tinned-iron plates. The heat applied should not exceed that of boiling water, and a lower temperature is preferable. The oil may also be extracted by slightly roasting the seeds and then boiling with water, or by the action of a solvent, such as carbon bisulphide. It is chiefly obtained as a by-product in the manufacture of chocolate and cocoa essences.

**Characters and Tests.**—Oil of theobroma (specific gravity, 0.990 to 0.998) occurs in oblong cakes, which break with a smooth fracture, and are yellowish-white when fresh, though they become whiter on keeping. The oil has an odour resembling that of cocoa, a bland and agreeable taste, and should be free from rancidity. It softens at  $26.6^{\circ}$  C., and melts between  $31^{\circ}$  and  $34^{\circ}$  C. The absence of paraffin, wax, stearin, tallow, suet, or other fats which may be used as adulterants of oil of theobroma, is proved by dissolving 1 gramme of the oil in 3 C.c. of ether (specific gravity, 0.735) and exposing the solution to cold. If the oil be pure, the liquid will not become turbid nor deposit a granular mass in less than three minutes, when cooled to  $0^{\circ}$  C.; whilst, after congelation, a clear solution should result on heating the mass to  $15.5^{\circ}$  C.

**Notes.**—In applying the ether test, it is desirable to use a stout test tube which can be securely corked during the process, so as to avoid loss of ether. Coco-nut oil, which is largely used as an adulterant of oil of theobroma, contains a much larger proportion of fatty acids than the latter; this increases the saponification value considerably and reduces the iodine value. Oil of theobroma consists chiefly of the glycerides of stearic, palmitic, and oleic acids, together with small quantities of the glycerides of arachidic, linolic, formic, acetic, and butyric acids. About 40 per cent. of stearic acid is obtainable from the oil, the iodine absorption of which is low, since the greater part of it consists of glycerides of fatty acids belonging to the stearic or saturated series. It is used for making suppositories, because

it is a hard solid, capable of being moulded at ordinary temperatures, and yet easily melts below the temperature of the human body. When the oil has been recently melted, the specific gravity on solidification is lower than that stated, owing apparently to some molecular disturbance being caused by the application of heat; the effects do not pass away entirely at once, and the specific gravity only attains its higher and final value after some time has elapsed. It has been stated that oil of theobroma will not turn rancid on keeping, but that statement is incorrect, though the tendency to rancidity is not so great as in the case of most other fats.

## Opium.

**Opium** is the dried latex or milky juice of *Papaver somniferum*, Linné (N.O. Papaveraceæ), obtained, by incision, from the unripe capsules of the plant and inspissated by spontaneous evaporation. The plant from which opium is chiefly obtained is understood to be *P. somniferum*, var. *album*, De Candolle, and it is cultivated in European Turkey, Asia Minor, Persia, India, China, etc. All parts of the plant yield a white, opaque, narcotic juice on incision, but the active principles appear to concentrate themselves in the juice contained in the unripe fruit. Opium, therefore, is obtained from the capsule only, which is especially rich in latex, the wall containing an elaborate branching and anastomosing system of laticiferous vessels, accompanying the fibro-vascular bundles. Transverse, oblique, or vertical incisions are made in the wall of the unripe fruit, after the petals have fallen, the direction and number of the incisions varying in different countries or districts, while great care is taken to avoid penetrating to the interior of the fruit, as part of the escaping juice would then be lost and the seeds prevented from ripening. After the lapse of twenty-four hours, the exuded juice has become partially dried in the form of tears near the edges of the incisions, and it is then scraped off by means of blunt knives, the scrapings being afterwards combined so as to form cakes, which are wrapped in poppy leaves (Turkey opium) or paper (Persian and Indian opium), and partially dried by exposure to the sun. The knives are frequently moistened with saliva to prevent the juice adhering to the blades. Portions of the epidermis of the capsule are frequently removed along with the exuded juice, and may constitute about one-twelfth of the whole product. In some districts (e.g., India) the adhesive and granular paste formed by the partially dried juice is placed, after collection, in small vessels, in which it is beaten into a homogeneous mass before being made into cakes. Capsules which have ceased to yield their juice by exudation are sometimes beaten up with a little water, and the liquid thus obtained is inspissated by artificial heat, an inferior quality of opium being thus obtained. Turkey opium is the best kind for medicinal purposes; it occurs in two varieties, which are exported from Smyrna and Constantinople respectively. Persian opium may occur in masses, sticks, or cakes; Indian opium occurs in flat cakes or round balls wrapped in oiled paper, and is only rarely exported to Europe; Chinese opium is almost entirely consumed in China. Opium used in the preparation of the tincture and extract



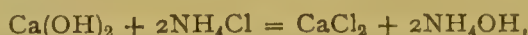
must contain not less than 7·5 per cent. of anhydrous morphine, calculated on the dry opium. For other officially recognised purposes, the drug—when powdered and dried at 100° C.—must contain from 9·5 to 10·5 per cent. of anhydrous morphine; if it should contain more than 10 per cent. it may be diluted to that strength with opium containing, when dry, not less than 7·5 per cent. of anhydrous morphine, or milk sugar may be added.

**Characters.**—Opium of any suitable variety is admitted by the official description, but Turkey opium should be preferred for making galenical preparations. It is of a rich light-brown to reddish-brown colour internally and coarsely granular. That exported from Smyrna is in rounded masses which are flattened or of irregular shape; they weigh from 250 to 1,000 grammes or more, are covered with poppy leaves, and sprinkled on the surface with the reddish-brown, triangular, winged fruits of a species of *Rumex*, which have been used in order to prevent the masses adhering together when packed in cases. The drug exported from Constantinople is in flattened cakes or masses of more regular shape, though they are equally variable in size; the poppy leaves covering them are entire, the broad midrib being usually very conspicuous and so placed as to divide the surface into two equal parts. The masses of Smyrna opium are distinguished by the presence of the portions of epidermis already referred to as being sometimes present in the drug; it is supposed that the masses are formed from drops of juice with adhering fragments of epidermis, the tears having been allowed to concrete before removal from the capsules, whereas in the case of Constantinople opium the juice is probably removed from the capsules before concretion and subsequent attachment to the epidermis take place. Persian opium is usually dark-brown and nearly smooth internally, having been kneaded into a homogeneous mass before being divided into short and bluntly conical pieces, weighing about 200 to 400 grammes each; it is usually wrapped in paper instead of leaves, but may also occur in short sticks or flat cakes, and is sometimes oily owing to the addition of oil after the collection of the juice. Opium possesses a strong, characteristic, narcotic odour and a bitter taste, due to the presence of morphine, meconic acid, etc. When fresh, it should be plastic and somewhat moist internally, also coarsely granular or of a nearly smooth consistence, and reddish-brown or chestnut-brown in colour. The drug becomes harder and darkens to blackish-brown on keeping.

**Test.**—In the official assay process 14 grammes of opium, dried at 100° C. and reduced to No. 50 powder, is triturated with 6 grammes of freshly prepared calcium hydroxide and 40 C.c. of distilled water until a uniform mixture results, after which 100 C.c. of water is added. The mixture is stirred occasionally during half an hour and then filtered; each 10·4 C.c. of the filtrate will represent 1 gramme of opium, the fraction (0·4 C.c.) being allowed for the increase in bulk produced by the soluble matters of the opium. The effect of this operation is to decompose the morphine meconate naturally present in the opium, insoluble calcium meconate being formed, whilst the morphine is set free, though kept in solution in the lime water produced by the excess of calcium hydroxide employed; the narcotine present in the opium is also dissolved. The next step is to add to



104 C.c. of the filtrate (representing 10 grammes of opium), 10 C.c. of 90 per cent. alcohol, 50 C.c. of ether (specific gravity, 0.735), and—after shaking the mixture—4 grammes of ammonium chloride; the shaking is then repeated frequently during half-an-hour, after which the mixture is set aside for twelve hours for the morphine to separate. The ammonium chloride reacts with the calcium hydroxide, thus—



and the morphine and narcotine are precipitated, as they are not soluble in the excess of ammonium hydroxide produced. The effect of the alcohol present is to cause the morphine to separate in a crystalline condition, so that it is more easily collected and washed, whilst the ether dissolves the narcotine. The ethereal layer is carefully removed and filtered to avoid the loss of any crystals of morphine, which may be mechanically suspended in it, and the filter is well washed with ether to remove all traces of narcotine. The use of two counter-balanced filters is resorted to in order that the effect of the repeated filtrations and washings on the weight of the filter containing the crystals may be eliminated, by making the two papers practically equal in weight when dried. The filters having been dried to remove the remaining ether, the aqueous liquid—containing soluble alkaloids, colouring matter, etc.—is then poured upon the inner one in such a way as to transfer to it the whole of the morphine crystals. The latter are next washed with a saturated solution of pure morphine in chloroform water until they are free from colour, the object of using morphinated water being to wash away the adhering mother-liquor without dissolving any of the precipitated morphine. Finally, the crystals are carefully dried and weighed, and 0.5 gramme of the dried precipitate is titrated with decinormal sulphuric acid solution in order to determine the amount of pure morphine present, because the precipitate consists of morphine, with a variable amount of non-alkaloidal impurities. Morphine is a mono-acid base, and forms the sulphate ( $\text{C}_{17}\text{H}_{19}\text{NO}_8$ )<sub>2</sub>,  $\text{H}_2\text{SO}_4$ ; hence 283.05 grammes of morphine ( $\text{C}_{17}\text{H}_{19}\text{NO}_8 = 283.05$ ) will be neutralised by 48.7 grammes of sulphuric acid ( $\frac{1}{2}\text{H}_2\text{SO}_4 = 48.67$ ). Since 1 litre of decinormal sulphuric acid contains 4.867 grammes of real acid, 1 C.c. will contain 0.004867 gramme, and as .

$$\begin{aligned} 48.67 \quad \text{grammes of } \text{H}_2\text{SO}_4 &= 283.05 \quad \text{grammes of Morphine.} \\ \therefore 0.004867 \text{ gramme of } \text{H}_2\text{SO}_4 &= 0.028305 \text{ gramme of Morphine.} \end{aligned}$$

Hence each cubic centimetre of decinormal sulphuric acid (containing 0.004867 gramme of  $\text{H}_2\text{SO}_4$ ) neutralised indicates 0.028305 gramme of pure anhydrous morphine in the precipitate titrated, and the weight of the crystals in the filter, corrected by the titration figure, plus 0.104 gramme (representing the average loss of morphine during the process), should amount to 1 gramme, or between 0.95 and 1.05 gramme, corresponding to about 10 (or from 9.5 to 10.5) per cent. of anhydrous morphine in the dry powdered opium.

**Notes.**—On incineration good opium should not yield more than 4 to 8 per cent. of ash; it may contain from 7 to 24 per cent. of moisture, and should yield from 55 to 65 per cent. of dry aqueous extract. The insoluble residue may contain portions of the epidermis of the poppy capsule, such as are normally present in the drug, but the presence of portions of the pericarp of the

fruit indicates adulteration with powdered poppy capsules. Though the official description permits the use of opium from any source, Turkey and Persian are the only kinds of which there is a regular supply, and Turkey opium alone is suitable for making galenical preparations, the Persian and Indian products both being unsuitable for that purpose on account of the large percentage of narcotine they contain. The chief constituent of opium is the alkaloid morphine, which is present, in combination with meconic and sulphuric acids, to the extent of 4 to 18 per cent. The official standard is about 10 per cent., but good Turkey opium easily yields from 12 to 16 per cent., and Persian contains from 10 to 12 or even 16 per cent. Indian opium does not usually contain more than 4 to 8.5 per cent. of morphine, but the Chinese drug has been found to yield from 4 to 11 per cent. Opium prepared from poppies cultivated in Germany is understood to have yielded nearly 22 per cent. of morphine, and a French sample has been found to yield nearly 23 per cent. The drug also contains from 1.5 to 12.5 per cent. of narcotine, 0.3 to 1.9 per cent. of codeine, and about 1 per cent. of other alkaloids, including thebaine, narceine, papaverine, meconidine, codamine, laudanine, laudanosine, lanthopine, protopine, cryptopine, rhœadine, oxynarcotine, pseudo-morphine, gnoscopine, xanthaline, tritopine, hydrocotarnine, etc., the whole, including morphine, normally constituting about one-fifth of the weight of the drug in the case of good dry opium. The alkaloids exist partly in the free state and partly combined with meconic and sulphuric acids. Apomorphine is an artificial alkaloid, prepared by heating morphine or codeine in a closed tube with excess of hydrochloric acid. Meconic acid is present to the extent of about 5 per cent.; meconin, meconiosin, and opionin—three indifferent substances—also exist in small quantity, and other constituents of the drug are mucilage, sugar, wax, caoutchouc, and salts of calcium, potassium, and magnesium. Starch, tannin, fat, and oxalic acid do not occur normally in opium, and their presence indicates adulteration. Stones, small shot, pieces of lead, gum, grape must, sugary fruits, and other mechanical impurities have also been used as adulterants of opium. [Dose.— $\frac{1}{2}$  to 2 grains.

## Oxymella.

**Oxymels** are syrupy preparations compounded with honey and vinegar or acetic acid—plain or medicated. The word oxymel means acid-honey. There are only two official formulæ for preparations of this class.

### **Oxymel.** OXYMEL.

A mixture of clarified honey with acetic acid and water, having a specific gravity of 1.320. [Dose.—1 to 2 fluid drachms.

### **Oxymel Scillæ.** OXYMEL OF SQUILL.

A vinegar of squill is prepared (more concentrated than that made by the official formula for Acetum Scillæ) and mixed with clarified honey, so as to produce an oxymel of specific gravity 1.320. If the more dilute official vinegar of squill were used, it would be necessary to concentrate the mixture with honey by evaporation, in order to obtain a product having the desired activity and keeping properties, and much acid would be lost during the process. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.



## Papaveris Capsulæ.

**Poppy Capsules** are the dried, nearly ripe fruits of the opium poppy, *Papaver somniferum*, Linné (N.O. Papaveraceæ). There are several varieties of the plant, the best known being the white and black poppies, so named because of the colour of their respective seeds. The former, var. *album*, De Candolle, is the plant which is cultivated for medicinal use in England, and from which the poppy capsules of commerce are chiefly obtained. It bears flowers of a white or silver-grey colour, and the fruit is a smooth, rounded, glaucous green capsule which becomes yellowish-brown as it ripens; it is from 5 to 10 Cm. in diameter, more or less flattened at the top or bottom, and crowned with a persistent stigma, the diverging segments of which are arranged in a circle upon the summit. The capsule contains numerous minute, whitish seeds, which escape when the fruit is perfectly ripe, through small openings beneath the stigma. The capsules are cut from the stems when nearly ripe, but before the seeds have escaped; they are then supposed to be richest in latex—the milky juice contained in the elaborate branching and anastomosing system of laticiferous vessels accompanying the fibro-vascular bundles in the wall of the fruit. The unripe fruit has a narcotic odour which is destroyed by drying, while its bitter taste is only partially retained.

**Characters.**—Poppy capsules are very variable in shape, some being nearly globular and others ovoid, whilst others again are much depressed at the summit and base. They also vary in diameter from 5 to 7·5 Cm. or more, are crowned by the stellately arranged stigmas, and are suddenly contracted below into a neck which is swollen just above the point of attachment to the peduncle, and marked there with the scars of the petals and sepals. The thin, dry, brittle pericarp is of a pale yellowish-brown colour and frequently marked with dark spots; from its inner surface a number of thin, brittle, membranous, parietal placentas, corresponding in number to the carpels, project into the cavity of the fruit, a transverse section of which shows it to be unilocular, but formed by the union of as many carpels as there are stigmas. The numerous minute, whitish seeds lie loose in the dried fruit; they contain an oily endosperm and, when examined under a lens, are usually seen to be reniform in shape and covered with distinct delicate reticulations. The capsules are inodorous, but the pericarp is distinctly bitter and the seeds have an oily taste.

**Notes.**—Fruits containing other than whitish seeds are not admitted by the official description. The “black” poppy (var. *nigrum*, De Candolle) usually has a red or violet flower, and the fruit, which is somewhat smaller and more globular than that of the white poppy, contains greyish or slate-coloured seeds which are known in commerce as maw seeds. The capsules contain the principal constituents of opium, including morphine and meconic acid. The amount of morphine present is very variable, from 0·16 to 0·28 per cent. having been yielded by capsules deprived of seeds, whilst both lower and higher amounts may be present at times. The seeds contain no morphine, but they yield about 50 per cent. of fixed oil (specific gravity, 0·924 to 0·937) which consists of the glycerides of linolic, oleic, palmitic, and stearic acids; it is



largely used for culinary purposes and, on account of its excellent drying properties, for mixing artists' colours. Its higher iodine absorption (from 137 to 143 per cent.) and comparatively high specific gravity serve to distinguish it from olive oil, which it sometimes used to adulterate.

## Paraffinum Durum.

**Hard Paraffin** is a mixture of the harder members of the paraffin series of hydrocarbons. Its chief source is the crude tarry oil obtained by the destructive distillation of shale. The oil is usually redistilled, and leaves coke and asphalt in the retort. The distillate is shaken with sulphuric acid to remove basic bodies, and afterwards with caustic soda solution to remove acid substances and phenols. The washed product is then redistilled and yields successively mineral naphtha, various kinds of burning and lubricating oils, and finally a thick oil which deposits paraffin wax on cooling. The crude wax is separated by pressure and dissolved in naphtha, being again crystallised from the solution by cooling and separated by pressure. The wax is then melted and filtered through animal charcoal to render it free from colour.

**Characters and Tests.**—Hard paraffin is colourless, semi-transparent, crystalline, inodorous, tasteless, and slightly greasy to the touch. Specific gravity, 0.82 to 0.94. It is insoluble in water, slightly soluble in absolute alcohol, almost entirely, although not freely, soluble in ether. An alcoholic solution should not redden litmus, showing that the acid used in the process of manufacture has been removed during the process of purification. Hard paraffin should melt at 54.4° to 57.2° C., and burn with a bright flame, leaving no residue.

**Notes.**—The melting point of hard paraffin will depend upon the temperature at which the various distillations have been conducted. As a rule, the higher the temperatures the lower is the melting point of the hard paraffin, because at high temperatures the hydrocarbons of high molecular weight are split up into two or more hydrocarbons of lower molecular weight. Hard paraffin consists chiefly of hydrocarbons ranging from  $C_{20}H_{42}$  to  $C_{80}H_{62}$ . The melting point required by the Pharmacopœia ranges from 54.4° C. to 57.2° C. A product of lower melting point is often used for imbedding substances before cutting microscopical sections. Ozokerite, a naturally occurring mineral wax found in Galicia, yields a product of higher melting point, when purified, and is chiefly used for making candles. It is remarkable that shale oil yields scarcely any fraction containing bodies of the soft paraffin or vaseline class.

## Paraffinum Liquidum.

**Liquid Paraffin** is a clear oily liquid, obtained from petroleum after the more volatile portions have been removed by distillation. When crude petroleum is fractionally distilled, the portion coming over below 60° C. constitutes petroleum ether; petroleum benzine, which must not be confounded with benzene or benzol from coal tar, is obtained between 60° C. and 90° C. The fraction between 90° and 120° C. consists chiefly of heptane,  $C_7H_{16}$ .

and octane,  $C_8H_{18}$ , and is known as ligröin. Between  $120^\circ$  and  $330^\circ$  C. fractions are obtained, which are used as illuminants under the name of kerosene. The fraction distilling between  $330^\circ$  and  $390^\circ$  C. is used for the preparation of paraffinum liquidum. It is treated successively with sulphuric acid and sodium hydroxide solution, in order to remove basic and acid impurities, then decolorised with charcoal, cooled to allow solid paraffins to crystallise, and the separated liquid again distilled, the fraction coming over above  $360^\circ$  C. being collected.

**Characters and Tests.**—Liquid paraffin is colourless, odourless, tasteless, and not fluorescent. Its boiling point should not be below  $360^\circ$  C. The specific gravity is officially stated to be from 0.885 to 0.890. If 3 C.c. be heated for ten minutes with an equal volume of sulphuric acid, in a test tube placed in boiling water, the mixture being frequently agitated, the separated layer of acid should not be coloured a deeper tint than pale brown. Presence of organic substances other than hydrocarbons (which are not charred by this treatment) will result in more or less blackening. Alcohol boiled with liquid paraffin and allowed to separate should be neutral to litmus, showing that the oil has been purified from acids. A mixture of 4 C.c. of the paraffin with 2 C.c. of absolute alcohol and 2 drops of a clear saturated solution of lead oxide in sodium hydroxide solution should remain colourless when kept at  $70^\circ$  C. for ten minutes, a brown to black precipitate of lead sulphide being formed if sulphur compounds be present.

**Notes.**—Some varieties of petroleum contain considerable quantities of sulphur compounds, which will be found after distillation in the lighter fractions. No sulphur exists in the fractions from which liquid paraffin is obtained, but a certain proportion may be derived from the sulphuric acid used in bleaching the oil. In the official test, the sodium hydroxide extracts the sulphur compounds from the oil, decomposing them with formation of sodium sulphide, which reacts with the lead to form a black precipitate or coloration due to lead sulphide. It is necessary to transform the sulphur compounds into sodium sulphide, in order that they may react readily with the lead solution. The specific gravity given in the Pharmacopœia is said to be rather higher than that observed for the purest commercial products, most of which will be found to be about 0.880.

## Paraffinum Molle.

**Soft Paraffin** is a semi-solid mixture of various paraffin hydrocarbons, usually obtained by purifying the residue obtained when crude petroleum is distilled and the fraction which distils between  $360^\circ$  or  $390^\circ$  C. has been separated, as described under "Paraffinum Liquidum." The residue in the still is purified by similar treatment with sulphuric acid, soda solution, and charcoal.

**Characters and Tests.**—Soft paraffin may be white or yellow. It is translucent, soft, unctuous to the touch, and free from acidity, alkalinity, or any unpleasant odour or flavour, even when warmed to  $50^\circ$  C. Specific gravity, at the melting point, 0.840 to 0.870. Soft paraffin melts at  $35.5^\circ$  C. to  $39.0^\circ$  C., or even somewhat higher, volatilises without giving off acrid vapours, and burns with a bright flame, leaving no residue, thus showing absence of mineral

substances. Insoluble in water, slightly soluble in absolute alcohol, freely soluble in ether, chloroform, and benzol. After heating with boiling sodium hydroxide solution the aqueous liquid, after separation, should yield no precipitate or oily matter on adding excess of acid. This test excludes admixture with fixed oils, fats, and resins which will be saponified by the sodium hydroxide. The alkaline soap solution will give a precipitate of insoluble fatty or resin acids on acidulation with dilute hydrochloric or sulphuric acid. As soft paraffin is a neutral hydrocarbon mixture, it will not be saponified or otherwise affected by the treatment with caustic soda.

**Notes.**—The chief sources of petroleum are America and Russia, smaller supplies being also obtained from India, Germany, and other countries. The composition of these earth oils varies considerably so far as regards the proportions of the various fractions obtained from them by distillation. The products obtained may be broadly divided into four fractions: (1) Mineral naphtha, (2) burning oils, (3) lubricating oils, (4) soft or semi-solid paraffins. The hard, liquid, and soft paraffins used in pharmacy consist chiefly of mixtures of the higher members of the paraffin series of hydrocarbons. Members of the unsaturated ethylene and acetylene series are also present in smaller quantities, and some paraffin products, particularly those derived from Russian oil, contain notable quantities of other hydrocarbons related to the benzene series. The crude natural materials, which comprise the sources from which the refined products are commercially prepared, are generally believed to result from the decomposition of the fossil remains of marine animals belonging to a former geological epoch. This decomposition is probably effected under great pressure, but not a high temperature. In favour of this view it may be mentioned that salt water often flows out in association with mineral earth oils, and that animal remains are usually found at the place of origin of mineral oils. Another theory is that the hydrocarbons were formed by the action of water upon metallic carbides in the interior of the earth, the water gaining access to the heated interior through fissures formed by upheavals on the earth's surface. In favour of this view is the fact that petroleum deposits occur in proximity to mountain ranges and, sometimes, in strata belonging to geological epochs when very little organic matter existed upon the earth. In addition to the earth oils and waxes, which are found ready-formed, bituminous shale (a kind of sedimentary rock readily splitting into layers, and containing fossil remains) is an important source of paraffinoid hydrocarbons, as is mentioned under "Paraffinum Durum." It is also noteworthy that fish oils, when destructively distilled under pressure, yield distillates containing a considerable proportion of paraffin hydrocarbons. The formulæ of the chief hydrocarbons in soft paraffin range from  $C_{16}H_{34}$  to  $C_{20}H_{42}$ .

## Paraldehydum.

Paraldehyde,  $C_6H_{12}O_3$ , is a product of the polymerisation of acetaldehyde by various acids and salts—*e.g.*, hydrochloric and sulphuric acids, zinc chloride, sodium acetate, etc. On the addition of small quantities of those substances, polymerisation occurs with evolution of heat, the paraldehyde being



separated in a crystalline condition by cooling the product to  $0^{\circ}\text{C}$ . The separated crystals are pressed between absorbent paper to remove adherent fluid, and rectified by distillation.

**Characters and Tests.**—Paraldehyde is a clear, colourless liquid (b.p.,  $124^{\circ}\text{C}$ .), having a characteristic ethereal odour, and an acrid, and afterwards cool, taste. It is soluble in 10 parts (most authorities state 8.5 parts) of water at  $15.5^{\circ}\text{C}$ ., less soluble in hot water, but miscible in all proportions with 90 per cent. alcohol and with ether. An aqueous solution should not affect solution of litmus. The specific gravity (0.998) of paraldehyde affords an important test of its purity. The liquid may be congealed to a clear crystalline mass, which melts at about  $10^{\circ}\text{C}$ . It affords no coloration on standing for two hours mixed with solution of potassium hydroxide, showing absence of ordinary aldehyde, which is converted into a yellow polymeric body—the so-called aldehyde-resin—by potash. It should be free from sulphates and chlorides, showing that the paraldehyde has been purified from the usual polymerising agents.

**Notes.**—The facility with which aldehydes polymerise and form condensation products is very characteristic of this class of bodies. Although the

constitution usually accepted for the aldehydes,  $\text{R}-\text{C}\begin{smallmatrix} \nearrow \text{O} \\ \searrow \text{H} \end{smallmatrix}$ , shows that they are

to be regarded as saturated compounds, yet the mode of linkage between the carbon and oxygen readily undergoes a change under certain conditions, so that the aldehyde behaves as if it were unsaturated and had the constitution

$\text{R}-\text{C}\begin{smallmatrix} \nearrow \text{O}- \\ \searrow \text{H} \end{smallmatrix}$ . It is thus capable of combining with two monad elements or

groups. For example, acetaldehyde, under the influence of reducing agents, takes up two atoms of hydrogen to form ethyl alcohol:—

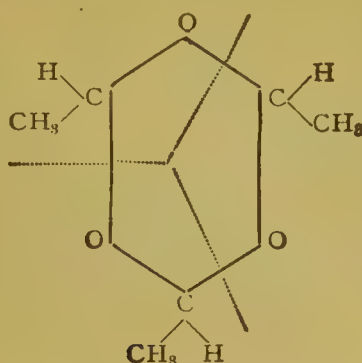


The formation of the additive compounds between aldehydes and ammonia, sodium acid sulphite, and hydrocyanic acid, are also explained on the assumption that the doubly linked oxygen atom  $=\text{C}=\text{O}$  (carbonyl oxygen) may become

singly linked, as represented  $=\text{C}\begin{smallmatrix} \nearrow \text{O}- \\ \searrow \end{smallmatrix}$ . The formation of paraldehyde from

acetaldehyde, under the influence of a small quantity of mineral acid, may also be explained in this way. Three molecules of aldehyde then combine to form this polymer, having the same empirical formula as acetaldehyde,  $\text{C}_2\text{H}_4\text{O}$ , but whose molecular weight determined by its vapour density and the freezing point method is three times as great—viz.,  $\text{C}_6\text{H}_{12}\text{O}_3$ . This polymerisation appears to result from three molecules of acetaldehyde, by the alteration

in the linkage of the oxygen atom, combining to form a closed ring composed of alternate carbon and oxygen atoms:—



It should be noted that paraldehyde no longer behaves like a typical aldehyde towards ammonia and sodium acid sulphite; it is not resinified by potassium hydroxide, and does not reduce silver ammonio-nitrate. All these reactions

depend upon the presence of the aldehyde group— $\text{C} \begin{smallmatrix} \text{O} \\ \diagup \\ \text{H} \end{smallmatrix}$  which is no longer

present in the paraldehyde molecule. Paraldehyde is reconverted into acetaldehyde by distillation with acids, and the ease with which this reverse change is effected tends to confirm the constitutional formula given above. It will be seen that the closed chain is formed of alternate oxygen and carbon atoms, and it is hence a hetero-cyclic compound, a cyclic compound being one in which the presence of a closed ring of elements is assumed. Such compounds are much more easily broken up than iso-cyclic compounds like benzene, which contain a closed ring of all carbon atoms. The combination between the carbon atoms of benzene is so stable that they are only separated by the most energetic chemical reagents. The formula is also supported by the refractive energy of paraldehyde, by its specific volume, and the valency of carbon, which can only be satisfied by the formula given. There is another polymer of acetaldehyde, known as metaldehyde—a solid crystalline body produced when aldehyde is treated with a trace of mineral acid at low temperatures. This also has a molecular formula like paraldehyde,  $\text{C}_6\text{H}_{12}\text{O}_3$ , and is probably a stereo-isomer of that body. In dispensing paraldehyde it is important that sufficient water should have been ordered for its complete solution, owing to the acrid burning taste of undissolved paraldehyde. It should also be remembered that it is less soluble in hot than in cold water. [Dose.— $\frac{1}{2}$  to 2 fluid drachms.]

## Pareiræ Radix.

**Pareira Root** is obtained from *Chondrodendron tomentosum*, Ruiz and Pavon (N.O. Menispermaceæ), a native of Brazil and Peru. The dried root alone is official, but occasionally pieces of stem are found in parcels of the root. The drug is known as “pareira brava,” and imported from Rio Janeiro, in South Brazil.

**Characters.**—Pareira root occurs in hard, heavy, long, and nearly cylindrical pieces, which are knotty, more or less twisted, and from 2 to 5 Cm. in diameter. It is covered with a thin blackish-brown bark, and marked externally with longitudinal furrows and transverse ridges and fissures. Internally, the root is yellowish-grey or brownish-grey, and the fractured surface when cut with a knife has a glossy, waxy appearance. The transverse section shows four or five well-marked concentric, or more or less eccentric, crenated zones, separated from each other by lighter lines of parenchymatous tissue. The innermost zone is usually from 6 to 12 Mm. in diameter, and each zone consists of a varying number of wedge-shaped wood-bundles with large pores, the bundles being separated by wide medullary rays. The root has no odour, but a decidedly bitter taste, due to the presence of alkaloid. Ash-yield, about 4 per cent.

**Notes.**—The nearly black outer surface, crenate outline of the woody zones, waxy surface when cut, and bitter taste suffice to distinguish pareira root from the different substitutes which are offered for it from time to time. The zones are usually concentric, incomplete eccentric zones being characteristic of a bitter false pareira. The stem of the plant producing the true drug is paler in colour than the root, has a more or less warty surface, and exhibits a small pith. The chief constituent of pareira root is from 2.5 to 3 per cent. of the bitter alkaloid bebeerine (pelosine or cissampeline), which is identical with the alkaloid, bebeerine, found in bebeeru bark (*Nectandra Rodiaei*), but not with that (buxine) existing in the bark of *Buxus sempervirens*. The drug is said to contain about 9 per cent. of free fatty acids (chiefly stearic), together with starch, tannin, mucilage, etc.; the yield of cold aqueous extractive is about 12 per cent. A menispermaceous root of unknown botanic origin is frequently substituted for pareira root; it is not so heavy or bitter, does not appear waxy when cut, and may also be distinguished by its decided brownish colour, the presence of larger vessels in the wood, and the greater number of woody zones, which are narrower than those of pareira root and not distinctly crenate. It contains a small quantity of an acid resin, but no starch and is almost destitute of fats or fatty acids; much more tannin is present than in pareira root, but less alkaloid (0.14 per cent.) and mucilage, while the yield of ash is less than 2 per cent., and that of aqueous extractive less than 10 per cent. Other roots have also been confused with true pareira, including that of *Cissampelos Pareira*, Linné (N.O. Menispermaceæ), which is now official in the Indian and Colonial Addendum, and is referred to in an appendix to this volume.

## Pepsinum.

**Pepsin** is an enzyme or soluble ferment obtained from the mucous lining of the fresh and healthy stomach of the pig, sheep or calf; it is a proteid-like body formed from the zymogen pepsinogen, which is secreted by glands imbedded in the tissue of the inner coating of the stomach. Pepsin acts on proteid substances when in slightly acid solutions, converting insoluble proteids into soluble parapeptone (or acid albumose), propeptone, and finally into peptone. Commercial pepsin is a mixture obtained chiefly from



the stomach of the pig, the digestive secretions of the sheep and calf being less active. It may be prepared by scraping the mucous membrane and, subsequently, drying and powdering the viscid pulp; but a more satisfactory article is obtained by removing the mucous membrane from the underlying muscular coats of the stomach and, after finely mincing it, allowing it to macerate for several days in water acidulated with about 0.2 per cent. of hydrochloric acid. During maceration, most of the membrane undergoes digestion, the liquid being strongly proteolytic, or capable of digesting proteid matter. After filtering the liquid from the undigested débris the pepsin can be thrown out of solution by saturating the acid extract with sodium chloride, ammonium sulphate, or some other neutral salt. If the mucous membrane be extracted with glycerin, the proteids are not dissolved to the same extent as when hydrochloric acid is used, but in neither case is the pepsin obtained pure. It may be freed from excess of salt by suspending it in water in a dialyser, the adhering salt then diffusing away, while the pepsin—being a colloidal substance—remains in solution in the dialyser; it is soluble in water when prepared as described, though not in the strong saline solution. From the aqueous solution, the pepsin can be reprecipitated by the addition of excess of alcohol, after which it is collected and dried at a low temperature, or the aqueous solution may be evaporated *in vacuo*, and the residue powdered. In the latter case the product will contain peptones, as well as the proteoses of digestion found in pepsin separated from aqueous solutions by saturation with neutral salts. Scale or granular pepsin is prepared by allowing the finely divided inner coatings of the stomachs to digest in a mixture of hydrochloric acid and water as already described, the liquid being strained when solution is complete and evaporated to a syrupy consistence at a temperature not exceeding 45° C. If scales be required, some dextrin must be added to the strained syrupy fluid, which is then spread in thin layers upon glass plates, and allowed to evaporate to dryness in an atmosphere free from dust; grains or so-called “crystals” of pepsin are obtained by evaporating the syrupy fluid so as to produce thicker sheets, like fine glue, which are broken up into small pieces when dry. No commercial pepsin is absolutely pure; that prepared by scraping the stomachs contains a large proportion of the tissue elements of the mucous membrane, precipitated pepsin usually contains salt and the products of the decomposition of primary proteid matter, scale and granular pepsins contain both the proteoses of digestion and peptones. Three distinct types of pepsin are found in commerce: (1) those which are insoluble in water without the addition of traces of acid; (2) those which dissolve in water, forming clear solutions; (3) those which are not entirely soluble in water or in dilute hydrochloric acid.

**Characters and Tests.**—Pepsin may occur as a light yellowish brown or white powder, or as pale-yellow scales or grains. It should be free from any trace of putrescence, having only a faint odour and a slightly saline taste. It is liable to absorb moisture from the air, and is moderately soluble in water, but is almost insoluble in 90 per cent. alcohol, though officially stated to be:

soluble in about 100 parts of that liquid. The proteolytic or proteid-digesting power of pepsin is such that it ought to dissolve at least 2,500 times its weight of hard-boiled white of eggs. If, therefore, 12·5 grammes of coagulated and firm white of fresh eggs be digested with 125 C.c. of acidulated water—prepared by mixing one gramme of hydrochloric acid (specific gravity 1·160) with 156 C.c. of water, and containing 0·2 per cent. of hydrogen chloride—and 0·005 gramme of pepsin, for six hours, at a temperature of 40·5° C., the mixture being shaken frequently, the albumin should dissolve, leaving only a few small flakes in an almost clear solution. The white of eggs must be prepared by boiling quite fresh eggs in water for fifteen minutes, then immersing them in cold water until sufficiently cool to handle, after which the whites must be separated, washed with water to remove any traces of yoke or membrane, dried with a clean towel, at once rubbed through a sieve having twelve meshes to a centimetre, and the product used before it has lost moisture. It is passed through a sieve in order to obtain it in a uniform condition for exposure to the digestive action of the pepsin; if large pieces be used, the albumin is digested more slowly, owing to the smaller extent of surface exposed. The albumin is converted by the pepsin first into soluble acid albumin, then into albumose (proteose) and peptone. This test serves to imitate the condition in which most of the proteids of food are introduced normally into the stomach—*i.e.*, cooked and coagulated. In carrying out the test the materials are best placed in a heavy stoppered bottle, having a capacity of 150 to 200 C.c., which should be allowed to stand in a large saucepan containing sufficient water at 40·5° C. to cover the shoulder of the bottle, so that the level of the enclosed mixture will be well below the level of the water in the bath; the gas flame beneath the saucepan should then be adjusted, so that the temperature of the water can be maintained within about one degree of that specified, and the water should be stirred frequently with the thermometer immersed in the bath, in order to keep the temperature uniform throughout the liquid during the six hours.

**Note.**—Though pepsin can be obtained capable of dissolving much more than 2,500 times its weight of fresh hard-boiled white of eggs, in comparing specimens it is important to test them under uniform conditions. It must also be noted that the amount of albumin dissolved does not indicate the real digestive power of pepsin; that must be measured by the amount of peptone produced in a given time and under definite conditions, the action of the pepsin being thus carried a stage farther than when the albumin is merely dissolved. The soluble enzyme of which commercial pepsin essentially consists renders insoluble proteids soluble, converting them into proteoses and peptones. It can be prepared in a relatively pure condition by extracting the finely-divided mucous membrane with water containing 5 per cent. of phosphoric acid and, after straining off the débris, filtering the extract and adding lime water almost to the point of neutralisation. The calcium phosphate thus precipitated carries down with it most of the enzyme, mixed with a certain amount of proteid matter. The precipitate is dissolved in dilute hydrochloric acid and lime water again added to cause precipitation, the enzyme clinging to the precipitate being obtained much purer than before. The precipitate is again dissolved in dilute



hydrochloric acid and a solution of cholesterin in a mixture of alcohol and ether (4 to 1) passed through a thistle funnel reaching to the bottom of the containing vessel. The cholesterin, being insoluble and lighter than water, rises to the surface, carrying with it the enzyme and, after the separated matter has been washed with very dilute acetic acid and subsequently suspended in a little water, the cholesterin is removed by repeated agitation with ether, leaving the purified enzyme dissolved in the water. If, instead of adding cholesterin to the hydrochloric acid solution, the latter be dialysed until it is free from chlorides and phosphates, the nearly pure enzyme is left in the dialyser, further purification being secured by repeating the operation, much insoluble proteid matter being removed by repeatedly redissolving the precipitate in dilute hydrochloric acid and dialysing. The purified product so obtained gives some proteid reactions and contains less than 1 per cent. of phosphorus. It is to be noted that pepsin can only carry out its specific digestive action when it is in a state of combination with a weak acid—hydrochloric, nitric, phosphoric, oxalic, etc. Its action is influenced by several physical conditions, of which the most important is temperature. The maximum activity of the enzyme is from 40° to 60° C.; the activity ceases at 70° to 80° C., the enzyme being coagulated at the higher temperature. It has been pointed out that while the action of pepsin in acid solutions is stopped, in the absence of peptone, at a temperature of 55° C., the enzyme remains active, if peptone be present, after being heated to 70° C. The best results are obtained when the digestive fluid contains from 0.01 to 0.05 per cent. of the enzyme. Alkaline salts, such as sodium carbonate, exercise a prejudicial effect upon the action of the pepsin, and neutral salts, such as ammonium sulphate and sodium chlorides, have a markedly retarding effect; the alkaline salts destroy the enzyme entirely, but neutral salts only inhibit its action, and, if they are removed by dialysis or other means, the pepsin will still be capable of effecting proteolysis. [*Dose*.—5 to 10 grains.]

## Phenacetinum.

**Phenacetin**, para-acet-phenetidín,  $C_2H_5O \cdot C_6H_4 \cdot NHCOCH_3$ , is obtained from phenol by a somewhat complicated series of operations which may be summarised as follows:—Phenol is liquefied by the addition of a small quantity of alcohol and run slowly into a strong solution of sodium nitrate to which excess of sulphuric acid has been added. This is equivalent to a fairly strong nitric acid, the excess of sulphuric acid taking up the water formed by the nitration of the phenol—



In accordance with the laws of substitution (see page 210), a mixture of ortho- and para- nitro phenols is thus obtained, but none of the meta-compound. The reaction mixture is kept cool during the addition of the phenol, and when the reaction is completed the mixed nitro-phenols can be separated as an oily layer. To separate the ortho-nitro-phenol, which is not wanted, advantage is taken of the fact that the ortho-compound is volatile with steam while the para-compound is not. The oily layer is therefore introduced into a retort with some water and steam blown through. When no more o-nitro-phenol comes over, the residue



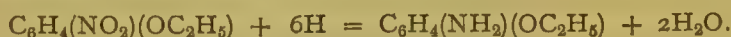
in the retort is decolorised with animal charcoal and the p-nitro-phenol crystallised out. The hydrogen atom of the phenol group is now to be replaced by the ethyl group. This is accomplished by preparing the potassium-nitro-phenol by the action of caustic potash—



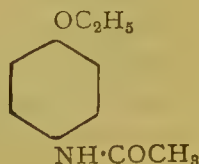
The potassium compound is then heated with ethyl iodide, which effects the substitution of the  $\text{C}_2\text{H}_5$  group for potassium—



The nitro group is not affected in either of these reactions, which are typical of the behaviour of phenols in the preparation of their potassium (or sodium) and alkyl derivatives. Compare, for example, potassium phenol (phenate or carbolate), anisol,  $\text{C}_6\text{H}_5(\text{OCH}_3)$ , and phenetol,  $\text{C}_6\text{H}_5(\text{OC}_2\text{H}_5)$ . The nitro-phenetol is then reduced by nascent hydrogen (from zinc and hydrochloric acid) to the corresponding amido compound, just as nitro-benzene  $\text{C}_6\text{H}_5\text{NO}_2$  is reduced to aniline  $\text{C}_6\text{H}_5\text{NH}_2$ —



This amido compound is para-phenetidin—*i.e.*, a derivative of aniline containing an ethoxy group in the para position relatively to the amido group. The para-phenetidin is then acetylated by boiling with glacial acetic acid, and yields para-acet-phenetidin—

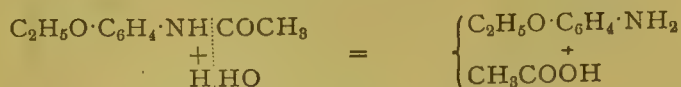


just as aniline yields acetanilide.

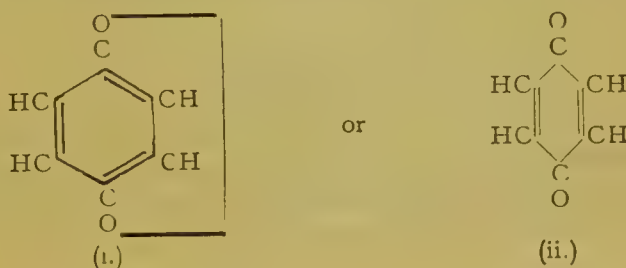
**Characters and Tests.**—Phenacetin occurs in white, tasteless, inodorous, glistening, scaly crystals, which are neutral to litmus, and melt at  $135^\circ \text{C}$ . It is very sparingly soluble in cold water, more freely in boiling water, and soluble in 20 parts of 90 per cent. alcohol. If 0.1 gramme be boiled with 2 C.c. of hydrochloric acid for half a minute it will yield a liquid which, diluted with ten times its volume of water, cooled and filtered, assumes a deep red coloration on the addition of solution of chromic acid. This test depends upon the saponification of phenacetin to acetic acid and para-phenetidin, the latter being oxidised by the chromic acid to quinone. Heated with free access of air it burns, leaving no residue, indicating absence of fixed mineral impurities. Sulphuric acid dissolves it without colour, while many possible adulterants, sugar, *e.g.*, are charred by the reagent. A cold, saturated aqueous solution should not become turbid on the addition of solution of bromine, while acetanilide gives an insoluble bromo derivative. A mixture of 0.3 gramme of phenacetin with 1 C.c. of 90 per cent. alcohol should not acquire a red tint when diluted with three times its volume of water, and boiled with 1 drop of volumetric solution of iodine. Para-phenetidin, which may be present through incomplete acetylation in the last stage of manufacture, responds to this test.

**Notes.**—The absence of unacetylated para-phenetidin is important, as that substance is said to be more toxic than phenacetin. Phenacetin is easily

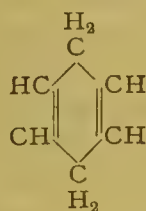
distinguished from phenazone by the solubility of the latter. If acetanilide be present the mixture melts below  $100^{\circ}$  C. When phenacetin is boiled with hydrochloric acid, it is saponified, para-phenetidin and acetic acid being regenerated.



On the addition of chromic acid the para-phenetidin is oxidised chiefly to quinone, and this, reacting with other substances produced at the same time, gives rise to a deep red dye substance. This formation of quinone is characteristic of many para-di-derivatives of benzene, the two substituting groups being eliminated and replaced by an oxygen atom. Quinone is one of those bodies which behave towards various reagents in such a way that its constitutional formula may be written in two ways—



Bodies like quinone are said to be "tautomeric." For a description of tautomerism and evidence in favour of the two constitutional formulæ for quinone given above, reference should be made to a text-book of organic chemistry. Formula (i.) shows quinone as a peroxide of a typical benzene ring, while formula (ii.) exhibits it as a diketone of the reduced (di-hydro) benzene compound—



The bromine test is very interesting. When acetanilide is brominated ortho- and para-brom-acetanilide are produced, but not meta-brom-acetanilide, in accordance with the laws of substitution, reference to which has been given above. By inspecting the constitutional formula for phenacetin it will be seen that the para-brom compound cannot be formed, because the para position is already occupied by the ethoxy group. Moreover, the remaining four positions not occupied by the ethoxy or acetamido groups are meta positions relatively to one or other of these, and since bromine entering a benzene ring already containing  $\text{OC}_2\text{H}_5$  or  $\text{NH}_2$  cannot take up the meta position, substitution by bromine does not take place, and no bromo-derivative is therefore produced by phenacetin under these conditions, as in the case of acetanilide. The compound is then said to be "protected." Phenacetin is closely related to

acetanilide. It is para-ethoxy-acetanilide—*i.e.*, it contains the ethoxy group,  $\text{OC}_2\text{H}_5$ , in the para position relative to the amido residue.

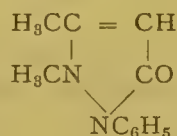


Both these compounds have antipyretic and analgesic effects, but acetanilide sometimes produces very undesirable after-effects, which are said to be due to the liberation of aniline,  $\text{C}_6\text{H}_5\text{NH}_2$ , in the body. Aniline is easily derived from acetanilide by the splitting off of the acetyl group. Phenacetin under the same conditions probably yields the corresponding para-ethoxy aniline (phenetidine)  $\text{C}_6\text{H}_4(\text{OC}_2\text{H}_5)(\text{NH}_2)$ , which is said to be less toxic than aniline.

[Dose.—5 to 10 grains.

## Phenazonum.

**Phenazone, Antipyrine**, or phenyl-dimethyl-iso-pyrazolone, is obtainable from phenyl-hydrazine by interaction with aceto-acetic ether, and the subsequent interaction of the resulting phenyl-methyl-iso-pyrazolone with methyl iodide. Its constitution is indicated by the following formula—



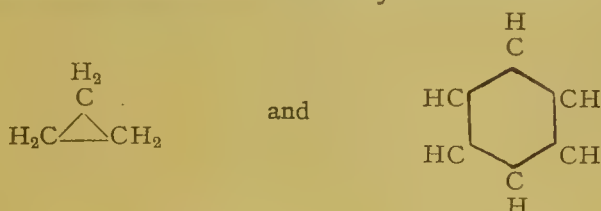
The preparation of phenazone is described in the "Notes" which follow.

**Characters and Tests.**—Phenazone occurs in colourless and inodorous scaly crystals with a bitter taste, which melt at  $113^\circ \text{C}$ . It is soluble in its own weight of water (compare phenacetin and acetanilide), in  $1\frac{1}{3}$  parts of 90 per cent. alcohol, or of chloroform, and in 40 parts of ether. If 0.1 gramme of sodium nitrite and 12 C.c. of a 1 per cent. aqueous solution of phenazone be mixed, a nearly colourless liquid is yielded, which turns deep green on the addition of 1 C.c. of diluted sulphuric acid, the colour being due to the formation of a nitroso-phenazone by the action of the nitrous acid which is liberated on the addition of the dilute sulphuric acid. An aqueous solution of the same strength mixed with an equal volume of nitric acid assumes a yellow colour, passing to crimson on warming. Solution of ferric chloride produces in a very dilute solution a deep red colour, which is nearly discharged by excess of dilute sulphuric acid. A 5 per cent. aqueous solution of phenazone gives with a 5 per cent. solution of mercuric chloride a white precipitate, which disappears on boiling, but reappears on cooling. This precipitate is a double compound formed by virtue of the basic nature of phenazone, and is much more soluble in hot than cold water. The aqueous solution of phenazone should be neutral to litmus and unaffected by hydrogen sulphide. Two C.c. of a one per cent. aqueous solution should be coloured green by two drops of fuming nitric acid, the nitroso-compound already referred to being produced by the nitrous acid always present in *fuming*

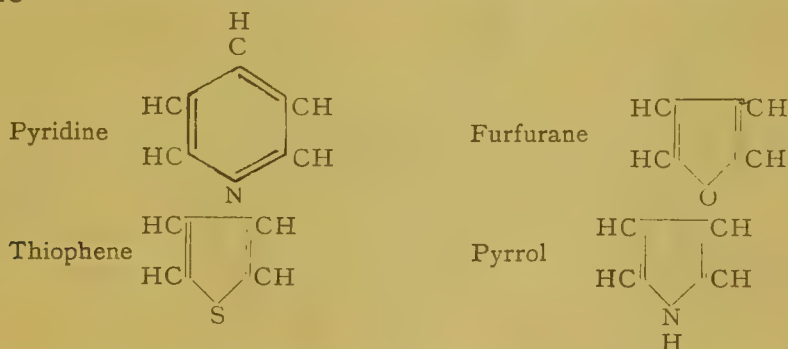


nitric acid. On the addition of three or four drops more acid and boiling decomposition occurs, with appearance of a red colour.

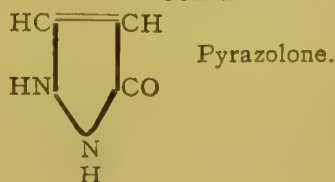
**Notes.**—The constitution of phenazone is somewhat difficult to understand. The constitutional formula given in the Pharmacopœia shows that it is a phenyl-dimethyl derivative of a body called pyrazolone. In order to explain the nature and constitution of this body it will be necessary to discuss the principles of the scheme of classification adopted in organic chemistry. Carbon compounds may be broadly divided into (1) fatty or aliphatic compounds and (2) benzene or aromatic compounds. The substances comprised in the first of these divisions are derived from hydrocarbons containing an open chain of carbon atoms, the term aliphatic being derived from the Greek word meaning "fat." The second division—the benzene compounds—are characterised by containing a closed chain or ring of carbon atoms, and for this reason are also known as "cyclic" compounds. Many substances are now known, however, which contain a closed ring not composed, like benzene, entirely of carbon atoms, but of oxygen sulphur, and nitrogen as well. The "cyclic" compounds are hence further classified into "carbocyclic" or "isocyclic," containing a closed ring of all carbon atoms like trimethylene and benzene—



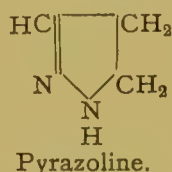
—and "heterocyclic" compounds, which contain in the closed ring other elements as well as carbon. The most familiar examples of heterocyclic compounds are—



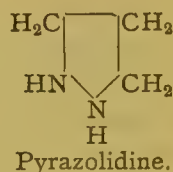
The scheme of classification is then as follows:—1. Aliphatic or open-chain compounds. 2. Cyclic or closed-chain compounds, divided into—(a) Carbocyclic or isocyclic compounds; (b) heterocyclic compounds. Pyrazolone, the ring nucleus characteristic of phenazone, is, therefore, a heterocyclic compound containing a closed chain of three carbon and two nitrogen atoms.



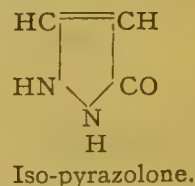
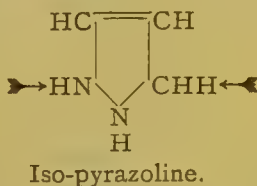
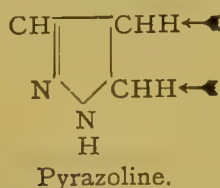
Its name and constitution recall the fact that it belongs to the pyrrol group (see the foregoing formula for pyrrol). The connection is shown in the following way: pyrrol contains one nitrogen atom in the closed ring, while pyrazol is another heterocyclic compound of the same type, containing two nitrogen atoms in the ring. This is indicated by the introduction of the letters "az" in the name pyrazol. If pyrazol be treated with nascent hydrogen, it takes up two atoms and then four, giving



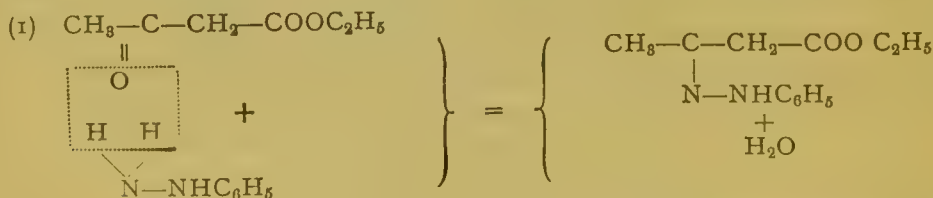
and



This behaviour is similar to that shown by benzene and pyridine when submitted to the action of nascent hydrogen. By carefully comparing the formulæ, it will be seen that pyrazolone differs from pyrazoline in containing an oxygen atom in place of two hydrogen atoms. It is therefore a ketone of pyrazoline, and this is indicated by changing the termination "ine" into "one." The prefix iso indicates that the iso-pyrazolone is one of the possible isomers of normal pyrazolone, the difference consisting in the position occupied by the two hydrogen atoms taken up in the reduction of pyrazol to pyrazoline.



The formation of phenazone is an example of the production of a cyclic compound from two open chains. It is made by treating phenol-hydrazine with aceto-acetic ether. The reaction first results in the production of a hydrazone, which is quite typical of the behaviour of phenol-hydrazine towards ketonic and aldehydic derivatives—*i.e.*, bodies which contain the carbonyl group  $\text{C}=\text{O}$ . Compare the reaction of phenol-hydrazine with sugars. Aceto-acetic ether is the ethyl ester of  $\beta$ -keto-butyric acid,  $\text{CH}_3 \cdot \overset{\gamma}{\text{CO}} \cdot \overset{\beta}{\text{CH}_2} \cdot \overset{\alpha}{\text{COOH}}$ . The carbon atoms, proceeding from the carboxyl group, are distinguished by the Greek letters in order to show where the substituting element or group is believed to occur. The reaction between  $\beta$ -keto-butyric ethyl ester and phenyl-hydrazine may be represented in two stages—

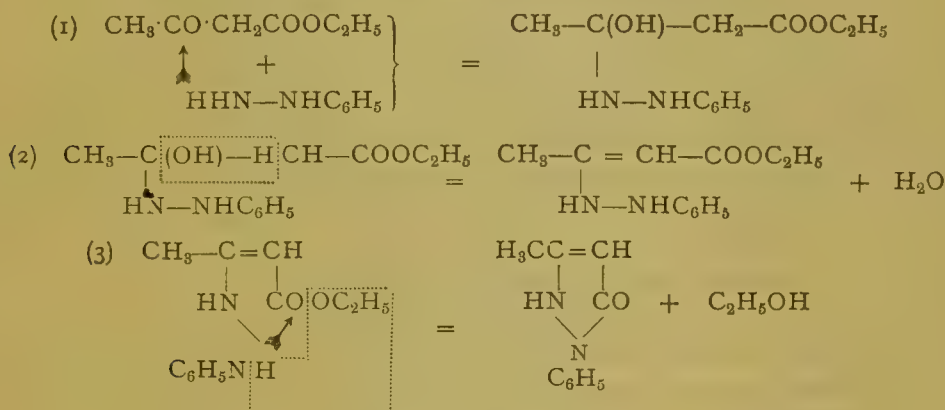


a molecule of water being produced from the oxygen of the ketone group and the hydrogen of the amido group in the phenyl hydrazine. This is the characteristic reaction referred to above resulting in the formation of a hydrazone. When

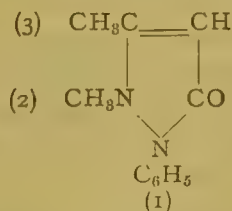
this is heated a molecule of alcohol is eliminated, with formation of the closed ring—the pyrazolone derivative—



The body so produced is phenyl-methyl-pyrazolone, but the reaction is not quite so simple as represented, because phenyl-methyl-iso-pyrazolone is actually obtained. (Compare the formulæ for normal and iso-pyrazolone previously given.) The most probable explanation of this apparent wandering of a hydrogen atom is shown in the equations below, where (1) an additive compound is first formed, the carbonyl oxygen of the ketone group being converted into hydroxyl, (2) water is eliminated by the union of the hydroxyl and a hydrogen atom of the neighbouring  $\text{CH}_2$  group, and (3) separation of alcohol with formation of phenyl-methyl-iso-pyrazolone.



The phenyl-methyl-iso-pyrazolone is then heated with methyl iodide and methyl alcohol, by which substitution of a methyl group is effected for a hydrogen atom in the position shown below, such a compound being further distinguished from possible isomers, by describing it as (1), (2), (3), phenyl-dimethyl-iso-pyrazolone to indicate the position taken up by the groups entering the ring



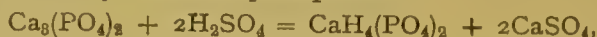
It should also be remembered that phenazone yields the green compound with spirit of nitrous ether, since the latter contains free nitrous acid. The incompatibility may, however, be avoided by adding bicarbonate of sodium or potassium before the phenazone since the latter is not acted upon by the alkali nitrite, but only by free nitrous acid. [Dose.—5 to 10 grains.]

[Dose.—5 to 10 grains.

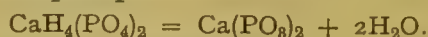


## Phosphorus.

**Phosphorus** is a solid non-metallic element obtained from calcium phosphate. This is treated with sufficient sulphuric acid to yield the soluble superphosphate or primary calcium phosphate—



and the solution of the soluble phosphate is filtered from the insoluble calcium sulphate. The liquid is mixed with charcoal or ground coke, evaporated to dryness and strongly heated, by which the superphosphate loses water and is converted into calcium metaphosphate—

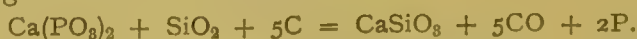


The mixture of carbon and metaphosphate is then raised to a higher temperature, when phosphorus in vapour mixed with carbon monoxide is evolved and passed into water so that the phosphorus is condensed without coming into contact with air—



**Characters and Tests.**—Phosphorus is semi-transparent, waxlike solid, which emits white vapours and is luminous in the dark when exposed to air. Specific gravity, 1.77. It is soft and flexible at common temperatures; melts at 44° C., ignites in the air at a temperature a little above its melting point, burns with a luminous flame, and produces dense white fumes of phosphoric anhydride ( $\text{P}_2\text{O}_5$ ). The luminosity of the flame is due to the incandescence of particles of anhydride which are raised to a white heat by the heat of combustion. Phosphorus is insoluble in water, soluble in about 350 parts of absolute alcohol, 80 parts of olive oil or ether, 25 parts of chloroform, half its weight of carbon bisulphide, and also in oil of turpentine. 1 gramme should be attacked slowly and be dissolved without residue on being boiled with 5 C.c. of strong nitric acid diluted with an equal volume of water, and the resulting solution should show no characteristic reaction with the tests for arsenium, and contain only traces of sulphate.

**Notes.**—The reaction involved in the last stage of phosphorus manufacture described above is explained by observing that calcium metaphosphate may be regarded as derived from one molecular weight each of calcium oxide and phosphoric anhydride  $\text{CaO}, \text{P}_2\text{O}_5 = \text{Ca}(\text{PO}_3)_2$ . At the high temperature of the furnace a portion of this  $\text{P}_2\text{O}_5$  is reduced by the carbon until the proportion  $3\text{CaO} : \text{P}_2\text{O}_5$  is attained, which corresponds to normal calcium phosphate,  $\text{Ca}_3(\text{PO}_4)_2$ , so that only two-thirds of the phosphorus is obtained in the distillate. The addition of sand is said to increase the yield, since the silica, of which it is mainly composed, displaces the remaining one-third phosphoric anhydride forming calcium silicate—



Phosphorus may also be prepared by means of the electric furnace, by heating a mixture of ordinary calcium phosphate, sand, and carbon. For the detection of arsenic occurring as an impurity in phosphorus the Pharmacopœia directs the phosphorus to be boiled with nitric acid, and it is stated that the resulting solution should yield no characteristic reaction with the tests for

arsenium. The phosphorus is thereby converted into phosphoric acid, and any arsenic present will also be oxidised to arsenic acid. In applying the official or other tests for arsenic it is necessary to bear carefully in mind the conditions under which the work is being done. For example, the solution to be tested contains some undecomposed nitric acid, in addition to the phosphoric acid. If, now, sulphuretted hydrogen be passed through the solution the nitric acid present will react with the sulphuretted hydrogen and produce a yellowish precipitate of sulphur, which might be mistaken for arsenic sulphide. Before applying the stannous chloride test, it would be advisable to evaporate the solution to a small bulk to remove the excess of nitric acid. This evaporated product, after redilution, should give no precipitate with sulphuretted hydrogen, but it should be remembered that arsenic in the condition of arsenic acid must be reduced to arsenious acid before a precipitate of arsenious sulphide is obtained. The reduction is accomplished by the sulphuretted hydrogen itself, but may be more quickly produced by the addition of sulphurous acid. In applying the special tests for arsenates the similarity of phosphates and arsenates must be remembered. With nitric acid and ammonium molybdate a yellow precipitate is produced by both. Ammonium magnesium phosphate and the corresponding arsenate are also indistinguishable in appearance and are produced under similar conditions. The colour of the silver salts is, however, very different, but a trace of arsenate of silver would hardly be detected by this means in presence of a large excess of silver phosphate, which would also be precipitated at the same time. [Dose.— $\frac{1}{100}$  to  $\frac{1}{20}$  grain.]

## Physostigmatis Semina.

**Calabar Beans** are the ripe seeds of *Physostigma venenosum*, Balfour (N.O. Leguminosæ), which is indigenous to Western Africa, growing especially near the mouths of the Old Calabar and Niger Rivers. The fruits of the plant are legumes about 15 to 18 Cm. long, which contain two or three large poisonous seeds, known as Calabar or "ordeal" beans, the latter name being applied to them because they have been used as a test of the guilt or innocence of suspected criminals or witches. If, after administration of the crushed seeds mixed with water, the suspected person succumbed, his guilt was considered proved.

**Characters.**—Calabar beans are large reddish-brown or chocolate-brown oblong-reniform seeds, usually about 25 Mm. long, 18 Mm. broad, and 12 Mm. thick. They are nearly flat or only slightly convex on one side, but boldly curved on the other; a broad deep groove (the hilum) extends nearly the entire length of the curved margin and passes completely round one end of the seed. The lips of the groove are thickened and paler in colour than the bottom, where it is black, with a distinct fine brown furrow in the middle. Portions of a white papery funiculus are occasionally found on the hilum, and at one end the micropyle appears as a minute depression. The hard, thick testa or outer seed-coat is seen to be somewhat rough when examined under a lens; it encloses two firm white starchy cotyledons which are curved so as to enclose

between them a large lenticular cavity filled with air, the presence of which enables the seed to float in water. The small white radicle will be found attached to one of the separated cotyledons, near the micropyle. The seed contains no endosperm. Moistened with potassium hydroxide solution the embryo becomes pale yellow. The seeds have no marked taste or odour. Ash-yield, about 4 per cent.

**Notes.**—The seeds of *Physostigma cylindrospermum* are nearly cylindrical and have a shorter hilum than Calabar beans; other substitutes which have been offered are the seeds of *Mucuna urens*, *Entada scandens*, and *Pentaclethra macrophylla*, all of which differ widely in appearance from Calabar beans, and cannot well be mistaken for the latter. The chief constituent of Calabar beans is a poisonous crystalline alkaloid named physostigmine or eserine ( $C_{15}H_{21}N_3O_2$ ), which exists in the cotyledons only, to the extent of about 0.2 per cent.; other constituents of the drug are small quantities of the alkaloids eseridine and eseramine, together with starch, proteids, mucilage, and a phytosterol, named stigmasterin.

## Physostigminæ Sulphas.

**Physostigmine or Eserine Sulphate** is the sulphate ( $C_{15}H_{21}N_3O_2$ )<sub>2</sub>,  $H_2SO_4, xH_2O$ , of the alkaloid obtained from Calabar beans.

**Characters and Tests.**—Physostigmine sulphate forms minute yellowish-white crystals, which become red by exposure to air and light. They have a bitter taste and are highly deliquescent, also very soluble in water and soluble in 90 per cent. alcohol. The salt is neutral to litmus paper, affords the reactions characteristic of sulphates, and becomes red when shaken with dilute solution of potassium hydroxide, owing to the absorption of oxygen. If a minute portion of the salt be added to a few cubic centimetres of solution of ammonia, the liquid acquires a yellowish-red colour and, on evaporating the liquid to dryness on a water-bath, leaves a bluish residue, a solution of which in very dilute acids is dichroic, appearing red by reflected light and blue by transmitted light. A minute fragment of the salt will colour a few drops of fuming nitric acid yellow, the liquid darkening when evaporated on a water-bath and leaving a green residue. A dilute aqueous solution of physostigmine sulphate causes contraction of the pupil when applied to the eye. The salt leaves no ash when burned with free access of air, the absence of mineral impurities being thus indicated.

**Notes.**—The production of a red colour owing to absorption of oxygen, when exposed to the air in the presence of an alkali, is characteristic of physostigmine and its salts. The sulphate is preferable to the salicylate on account of its greater solubility, but does not keep so well, assuming the consistence of an extract when exposed to air and then being difficult to dispense. [Dose.— $\frac{1}{80}$  to  $\frac{1}{20}$  grain.]

## Picrotoxinum.

**Picrotoxin** is a neutral principle, or a mixture of neutral principles, obtained from *cocculus indicus*, the fruit of *Anamirta paniculata*, Colebrooke



(N.O. Menispermaceæ). The fruit is collected when ripe, and exported chiefly from Bombay and Madras. It has no odour and its pericarp is tasteless, but the seed is very bitter, owing to the presence of picrotoxin, a poisonous substance, which can be extracted by exhausting the drug with alcohol. On evaporating the liquid, separating the fat which is present, adding water to the filtrate and acidulating the solution, picrotoxin crystallises out.

**Characters and Tests.**—Picrotoxin occurs in bitter, colourless, inodorous prismatic crystals, which melt at  $192.2^{\circ}$  C. It is soluble in 330 parts of water, 35 of boiling water, 13 parts of 90 per cent. alcohol, or 3 of boiling alcohol; it is also soluble in 10 parts of potassium hydroxide solution, the resulting liquid reducing Fehling's solution immediately on boiling. When heated on platinum foil the crystals first melt and form a yellowish liquid, then become charred and, finally, completely dissipated. Picrotoxin dissolves in sulphuric acid (specific gravity, 1.843) to form a saffron-yellow solution. It is distinguished from alkaloids by not yielding a precipitate when a solution of mercuric chloride, platinic chloride, or tannic acid is added to its aqueous solution.

**Notes.**—The seeds of *cocculus indicus* contain about 1 to 1.5 per cent. of picrotoxin, which is said to be a mixture of 66 per cent. of picrotoxinin and 34 per cent. of picrotin, though that statement is disputed. It is accompanied in the seeds by a tasteless crystalline body, anamirtin or cocculin, and a large proportion of fat, while two alkaloids—menispermine and para-menispermine—are present in the pericarp of the fruit. [Dose.— $\frac{1}{100}$  to  $\frac{1}{20}$  grain.]

## Pilocarpinæ Nitras.

**Pilocarpine Nitrate**,  $C_{11}H_{16}N_2O_2$ ,  $HNO_3$ , is the salt of an alkaloid obtained from jaborandi leaves.

**Characters and Tests.**—Pilocarpine nitrate is a white, crystalline powder, soluble in 8 or 9 parts of cold water, slightly soluble (1 in 50) in 90 per cent. alcohol, and freely soluble in hot alcohol. With strong sulphuric acid it forms a yellowish solution which gradually becomes emerald-green in colour on the addition of potassium bichromate. A dilute aqueous solution of the salt causes contraction of the pupil when applied to the eye. The salt leaves no ash when burned with free access of air, the absence of mineral-impurities being thus indicated.

**Notes.**—Though less soluble than pilocarpine hydrochloride, the nitrate is more frequently used in this country. The melting point of the pure salt is from  $173^{\circ}$ – $178^{\circ}$  C., but the commercial salt is said to contain a varying quantity of isopilocarpine nitrate, which melts at  $158^{\circ}$  C., and thus lowers the melting point of the mixture materially. Pilocarpidine nitrate (m.p.  $137^{\circ}$  C.) is much more soluble in alcohol or water (1 in 2) than pilocarpine or isopilocarpine nitrate. [Dose.— $\frac{1}{20}$  to  $\frac{1}{2}$  grain.]

## Pilulæ.

**Pills** constitute a very convenient means of administering drugs whose physical properties admit of their being combined into a plastic mass suitable

for rolling and cutting into pilular form. They are portable and, if made with suitably chosen excipients, are not liable to deteriorate in medicinal properties when kept a reasonable length of time. The slight taste experienced by the patient in the act of swallowing may also be entirely removed by coating the pills by one or other of the methods in common use in the pharmacy. The pill-mass should be sufficiently hard and plastic to admit of the pills being made without crumbling or flattening. It should not become very hard on keeping unless the mass is very soluble; in this case hardness is not objectionable. In the official formulæ various excipients are employed, according to the nature of the substances to be massed, those chiefly employed being confection of roses and syrup of glucose. Confection of roses imparts plasticity on account of the sugar and mucilaginous constituents, while the beaten-up tissues of the rose petals mechanically aid the mass in retaining the shape imparted to it. Syrup of glucose also makes a plastic mass with most substances, which is not liable to become hard on account of the slightly hygroscopic nature of glucose. Pills made with simple syrup harden on keeping, but owing to the solubility of sugar they usually disintegrate satisfactorily. If the chief constituents of a pill form a mass too soft for rolling and cutting, the necessary consistence must be imparted by some hardening agent. For oily substances, soap is commonly employed, but if the softness of the mass be due to water, tragacanth is most efficient. Too much tragacanth must not be used, because the mass will become tough, springy, and difficult to form into spherical pills. Moreover, a tough mass of this nature does not readily disintegrate. Glycerin by itself can only be used in a limited number of cases, because it is so hygroscopic that pills containing it are apt to become damp and sticky on keeping. Water and alcohol may be used at times, but since they quickly and completely evaporate from the mass it is apt to become crumbly. Soap, when not incompatible, is a useful addition; it imparts plasticity, does not allow the mass to harden too rapidly, and causes the mass to disintegrate readily, even when its remaining constituents are insoluble in water. In most of the official pill-masses containing purgatives, it will be observed that some carminative or antispasmodic drug is introduced in order to allay the griping effects. For the most part those are substances containing essential oils, so that their presence enables the various masses to be distinguished by their odour. Most of the official formulæ are constructed to yield masses which retain their plasticity on keeping, so that portions may be rolled and cut as required. The following are official:—

**Pilula Aloes Barbadosis.** PILL OF BARBADOS ALOES.

Contains Barbados aloes and oil of caraway massed with hard soap and confection of roses. [Dose.—4 to 8 grains.

**Pilula Aloes et Asafetidæ.** PILL OF ALOES AND ASAFETIDA.

Contains Socotrine aloes and asafetida massed with hard soap and confection of roses. [Dose.—4 to 8 grains.

**Pilula Aloes et Ferri.** PILL OF ALOES AND IRON.

Contains Barbados aloes and exsiccated ferrous sulphate, with compound powder of cinnamon, massed with syrup of glucose. Soap is not used

in this mass, since it would react with the ferrous sulphate and produce, chiefly, a comparatively insoluble iron oleate. [Dose.—4 to 8 grains.

**Pilula Aloes et Myrrhæ.** PILL OF ALOES AND MYRRH.

Contains Socotrine aloes and myrrh, massed with syrup of glucose. The mass bearing this name formerly contained saffron, and was called Pil. Rufi. [Dose.—4 to 8 grains.

**Pilula Aloes Socotrinæ.** PILL OF SOCOTRINE ALOES.

Contains Socotrine aloes and oil of nutmeg, massed with soap and confection of roses. [Dose.—4 to 8 grains.

**Pilula Cambogiæ Composita.**—COMPOUND PILL OF GAMBAGE.

Contains gamboge, Barbados aloes, and compound powder of cinnamon, massed with hard soap and syrup of glucose. [Dose.—4 to 8 grains.

**Pilula Colocynthis Composita.**—COMPOUND PILL OF COLOCYNTH.

Contains colocynth pulp, Barbados aloes, scammony, resin, oil of cloves, and potassium sulphate, massed with distilled water. The reason for the presence of the potassium sulphate is not apparent, except as a triturant for the oil of cloves. Note the general similarity between the compound pill and compound extract of colocynth. [Dose.—4 to 8 grains.

**Pilula Colocynthis et Hyoscyami.** PILL OF COLOCYNTH AND HYOSCYAMUS.

Contains compound pill of colocynth and extract of hyoscyamus, the latter modifying the action of the purgative by its influence upon the intestinal nerves. [Dose.—4 to 8 grains.

**Pilula Ferri.**—IRON PILL.

Contains ferrous carbonate, produced by reaction between exsiccated ferrous sulphate and sodium carbonate, in presence of syrup mixed with a little water and glycerin. When the reaction is complete, the mixture is made into a mass by the addition of powdered tragacanth and gum acacia. Exsiccated salts are employed in place of crystallised ferrous sulphate and sodium carbonate, because the exclusion of the water of crystallisation contained in the two salts, which is liberated when the reaction takes place between them, allows of the reaction taking place between the iron salt and the alkali carbonate in the presence of a relatively considerable quantity of syrup and glycerin. These protect the ferrous carbonate, owing to the well-known property possessed by syrup and glycerin of retarding the oxidation of ferrous to ferric compounds. If the hydrous salts were employed under the same conditions, the mass produced would be so soft and aqueous that an undue proportion of gum acacia and tragacanth would be required to produce a plastic pill-mass. In making Pilula Ferri according to this formula, care should be taken to see that the salts employed are really free from water, since a very small quantity of water so introduced will produce a paste instead of a pill-mass. [Dose.—5 to 15 grains.



**Pilula Galbani Composita.** COMPOUND PILL OF GALBANUM.

Contains galbanum, asafetida, and myrrh, massed with syrup of glucose.

Also known as Compound Pill of Asafetida. [Dose.—4 to 8 grains.

**Pilula Hydrargyri.** MERCURY, OR BLUE PILL.

Contains 1 part metallic mercury in 3 of mass, finely divided by trituration with confection of roses, the mass being stiffened by the addition of powdered liquorice root.

[Dose.—4 to 8 grains.

**Pilula Hydrargyri Subchloridi Composita.** COMPOUND PILL OF MERCUROUS CHLORIDE.

Contains mercurous chloride, sulphurated antimony and guaiacum resin, massed with castor oil and alcohol (90 per cent.). Also known as Compound Calomel Pill, or Plummer's Pill.

[Dose.—4 to 8 grains.

**Pilula Ipecacuanhæ cum Scilla.** PILL OF IPECACUANHA WITH SQUILL.

Contains compound powder of ipecacuanha, squill, and ammoniacum, massed with syrup of glucose. The proportion of opium is about 5 per cent.

[Dose.—4 to 8 grains.

**Pilula Phosphori.** PHOSPHORUS PILL.

Phosphorus dissolved in carbon bisulphide is incorporated with a warm semi-solid mixture of white beeswax and lard. The solvent rapidly evaporates and leaves the phosphorus in a finely divided state, probably partly dissolved, in the fatty mixture. Some kaolin is then incorporated and the mass preserved under water to prevent the oxidation of the phosphorus. When dispensed, three parts of this mass are incorporated with one part powdered gum acacia. The pills should be varnished to preserve the phosphorus from oxidation.

[Dose.—1 to 2 grains.

**Pilula Plumbi cum Opio.** PILL OF LEAD WITH OPIUM.

Contains lead acetate and opium, massed with syrup of glucose; proportion of opium, about 12½ per cent.

[Dose.—2 to 4 grains.

**Pilula Quininæ Sulphatis.** PILL OF QUININE SULPHATE.

Contains quinine sulphate mixed with a small proportion of tartaric acid and massed by the addition of glycerin and tragacanth. The use of tartaric acid enables a quinine mass to be made by the use of a comparatively small proportion of excipient. This is important, because quinine, in ordinary doses, makes a bulky pill with plastic excipients alone. Many other acids appear to have the same effect as tartaric acid.

[Dose.—2 to 8 grains.

**Pilula Rhei Composita.** COMPOUND RHUBARB PILL.

Contains rhubarb, socotrine aloes, myrrh, and oil of peppermint, massed by the addition of hard soap and syrup of glucose.

[Dose.—4 to 8 grains.

**Pilula Saponis Composita.** COMPOUND PILL OF SOAP.

Contains opium massed by the addition of hard soap and syrup of glucose.

The proportion of opium is 20 per cent. The name is intended to conceal the fact that it contains opium. [Dose.—2 to 4 grains.

**Pilula Scammonii Composita.** COMPOUND SCAMMONY PILL.

Contains resins of scammony and jalap, and hard soap, dissolved in tincture of ginger, the solution being evaporated to a pilular consistence. The use of a considerable proportion of soap is necessary in order to ensure disintegration of the resinous mass.

[Dose.—4 to 8 grains.

**Pilula Scillæ Composita.** COMPOUND SQUILL PILL.

Contains squill, ammoniacum, and ginger, massed with hard soap and syrup of glucose. [Dose.—4 to 8 grains.

## Pimenta.

**Pimento** is the dried, full-grown, unripe fruit of *Pimenta officinalis*, Lindley (N.O. Myrtaceæ), which is indigenous to and common in the West Indies, Mexico, and South America, and is largely cultivated in Central America and Jamaica. The fruit is a small, green, spherical berry, which turns black or dark purple on ripening, and is then filled with a sweet pulp. As the fruit loses its aroma on ripening, owing to loss of volatile oil, it is collected as soon as it has attained its full size, but whilst yet green. On drying in the sun the fruit becomes reddish-brown; the stalks are then separated, and the fruit is ready for packing and exportation in bags and casks.

**Characters.**—Pimento fruit is of a dull reddish-brown colour, nearly globular, and varies usually from 5 to 8 Mm. in diameter. Each berry is crowned with the remains of a four-toothed calyx, which forms a raised ring, in the centre of which the remains of the style can be seen. The woody pericarp is thin, rough, and brittle, and a small scar at the base of the fruit indicates the point of attachment of the stalk or pedicel. A transverse section of the fruit shows that it consists of two cells, each of which contains a single brownish-black reniform seed, within which is a dark coiled embryo, but no endosperm. The warm aromatic odour and taste of the fruit, somewhat resembling those of cloves, are due to the presence of volatile oil, which is contained in glands imbedded in the pericarp and seeds. Ash yield, 2·5 to 5 per cent.

**Notes.**—The name “allspice” is frequently given to pimento, because it is supposed to possess the combined flavour of cloves and other spices; it is also known as **Jamaica pepper**, in allusion to the place where it is most largely produced. The remains of the calyx crowning the fruit and the presence of two single-seeded cells are distinctive characters of pimento. Cubebs are one-celled, one-seeded, dark grey in colour, and reticulated on the surface; black pepper is also one-celled and one-seeded. The most important constituent of pimento fruit is from 3 to 4·5 per cent. of volatile oil, consisting principally of eugenol, which is also the chief constituent of oil of cloves. The fruit also contains much tannin, fixed oil, gum, resin, sugar, etc. Eugenol, a phenol, is the chief odorous constituent of the oil, but the odour is modified by a sesquiterpene and other constituents.

## Piper Nigrum.

**Black Pepper** is the dried unripe fruit of *Piper nigrum*, Linné (N.O. Piperaceæ), a climbing plant which is indigenous to Southern India and cultivated in the Malay Archipelago, the West Indies, and South America, the chief supplies of the fruit being obtained from Sumatra, Singapore, Johore, Penang, Siam, etc. The plant is cultivated in much the same way as hops, but the poles are replaced by trees, which give shade as well as support. It bears small, whitish flowers, which cover thickly a cylindrical spadix or rachis, and are succeeded by globular berries, which turn red when ripe. As soon, however, as the lower berries on the rachis begin to change from green to red, the whole spike is picked and dried in the sun, the fruits then becoming dark brown or black owing to a decomposition of the tannin they contain. They are afterwards separated from each other and sorted, before being packed for exportation.

**Characters.**—Black pepper consists of dark brown or nearly black globular fruits, without stalks, and usually about 5 Mm. in diameter. At the apex of the fruit the remains of the sessile stigma can occasionally be traced, and a scar at the base indicates the point of attachment to the rachis. The thin dark pericarp is deeply and reticulately wrinkled, and encloses a single globular seed which completely fills the cavity. The seed is covered with a brown seed-coat, and contains a small endosperm near the apex of the fruit, in which is situated a minute embryo, but it consists chiefly of perisperm, which is yellowish and horny near the periphery, and whitish, mealy, and frequently hollow towards the centre. Both pericarp and seed contain oil-cells, the contents of which impart an aromatic odour and a pungent taste. Ash-yield, 4 to 7 per cent.

**Notes.**—The absence of a stalk and the presence of a single seed, which completely fills and adheres to the pericarp, are distinctive characters of black pepper. White pepper is produced by allowing the fruit to become nearly ripe, and then removing the outer portion of the pericarp by maceration in water and subsequent friction, the nearly smooth greyish-white surface consisting of the adherent inner portion of the pericarp, which is traversed from base to apex by about sixteen fibro-vascular bundles. Black pepper contains a pungent resin (chavicin), the crystalline alkaloid piperine, and from 1 to 2.3 per cent. of volatile oil, to which the characteristic odour is chiefly due, the taste being caused by the resin and alkaloid. The oil appears to consist of lævo-phellandrene and other terpenes; white pepper also contains volatile oil, but it is not known whether that is identical with the oil obtained from black pepper. The alkaloid piperine,  $C_{17}H_{19}NO_8$ , is present in black pepper to the extent of 5 to 8.25 per cent., while white pepper contains from 4 to 6.5 per cent. It can be obtained in crystals which slowly develop a peppery taste and are decomposed by alcoholic solutions of alkalies into piperic acid,  $C_{12}H_{10}O_4$ , and piperidine,  $C_5H_{11}N$ , a volatile base with an ammoniacal and peppery odour. Though a decomposition product of piperine, piperidine is said to be an invariable constituent of pepper, which also contains fat, starch, and colouring matter. Piperic acid yields crystals of piperonal (artificial heliotropin) on oxidation.



## Pix Burgundica.

**Burgundy Pitch** is a prepared resinous exudation, said to be obtained from the stem of the Norway spruce fir, *Picea excelsa*, Link (N.O. Coniferæ), a native of Europe and Northern Asia, but probably also obtained from other species. It is collected chiefly in Finland, but smaller quantities are obtained in the Black Forest and in the Jura Mountains. Portions of the bark are removed so as to lay bare the wood, or perpendicular channels, about 40 Mm. in width and depth, are cut in the stem. The oleo-resin contained in the schizogenous secretion ducts of the wood exudes when the stem is thus wounded, and, after solidifying, is scraped from the surface, purified by being melted in hot water, and strained. The opaque product so obtained may be further freed from the water it contains by re-melting and stirring freely in an open vessel.

**Characters and Test.**—Burgundy pitch is somewhat opaque, strongly adhesive, of a dull reddish-brown or yellowish-brown colour, and breaks with a clean, conchoidal fracture. Though hard and brittle, it flows and gradually takes the form of the vessel in which it is kept. The agreeably aromatic terebinthinate odour is especially marked when the drug is heated; the taste is sweet and aromatic, without bitterness. The drug is readily and almost entirely soluble in glacial acetic acid (1 in 1.5), as well as in 90 per cent. alcohol (1 in 20).

**Notes.**—It is doubtful whether Burgundy pitch was ever collected in the French province from which it takes its name, but it appears at one time to have been imported from Burgundy, and is now imported from Germany. Its reddish-brown tint is the result of exposure and loss of water from the surface. Factitious mixtures of colophony, turpentine, water, and palm oil are sometimes sold as Burgundy pitch, but they are devoid of the peculiar fragrance of the genuine article, and are much less soluble in glacial acetic acid; like the genuine article, they tend to become somewhat transparent and darker coloured on the surface, owing to loss of water. The heat of the body suffices to soften true Burgundy pitch, and it then becomes very adhesive. Burgundy pitch consists chiefly of  $\alpha$ - and  $\beta$ -picea-pimarolic acids; it also contains small proportions of picea-pimarinic and picea-pimaric acids and a resene (juro-resene), together with a small quantity of volatile oil to which its peculiar fragrance is due.

## Pix Carbonis Præparata.

**Prepared Coal Tar** is obtained by heating commercial coal tar to drive off the greater portion of the ammoniacal liquor it contains. When bituminous coal is subjected to dry or destructive distillation, illuminating gases are evolved and a variety of volatile decomposition products, including phenol, creosol, etc., are condensed into the thick dark liquid or semi-liquid coal tar, coke being left in the retort. The coal tar may be split up by fractional distillation into the following five distinct fractions, the figures given being average ones:—

Ammoniacal liquor, 5 per cent.; light oils, 3 per cent.; carbolic and creosote oils, 20 per cent.; anthracene oils, 12 per cent.; pitch, 60 per cent. By heating the crude coal tar in a shallow open vessel, maintaining the temperature at 49° C. for an hour and stirring frequently, the ammoniacal liquor it contains is driven off; the residue, which possesses strong antiseptic and parasiticide properties is used for medicinal purposes.

**Characters.**—Coal tar (specific gravity 1·1 to 1·2) is a nearly black, viscid liquid, with a strong, penetrating disagreeable odour. It is only slightly soluble in water, to which it imparts an alkaline reaction owing to the presence of ammonium compounds, thus distinguishing it from wood tar and oil of cade, both of which impart an acid reaction to water shaken up with them.

**Notes.**—The antiseptic and parasiticide properties of coal tar are due to phenol and its homologues, naphthalene and similar hydrocarbons, basic bodies of the pyridine and acridine class, and sulphur compounds, such as thiophene. When prepared coal tar is digested in strong tincture of quillaia, as in preparing Liquor Picis Carbonis, most of the aromatic substances it contains pass into solution, and the greater part of the pitch is left as a black insoluble residue. On adding water to the alcoholic solution most of the hydrocarbons and the higher phenols are precipitated, but the saponin substances derived from the quillaia bark emulsify them and a milky fluid results.

## Pix Liquida.

**Tar**, known as wood tar or Stockholm tar, is a bituminous semi-liquid obtained by destructive distillation from the wood of the Scotch fir, *Pinus sylvestris*, Linné (N.O. Coniferæ), and other species of *Pinus*, the wood of *P. palustris*, Miller, being largely used for the purpose in the Southern States of North America. The dead wood is usually selected for distillation: when it is heated strongly without access of air, gaseous, watery, and tarry products are given off, charcoal being left in the retort. In some districts the wood is cut into billets of convenient size, which are placed together in a large stack or pile upon a small circular mound of earth, the upper surface of which gradually declines from the circumference to the centre, where there is a cavity communicating by a conduit with a shallow ditch surrounding the mound. The pile is covered with earth, so as to prevent free access of air, a hole being left at the top of the mound, through which a light can be applied to the wood. The opening having been closed, a slow combustion is maintained, and the products of distillation collect in the cavity; they are then conveyed by the conduit to the ditch, whence the tarry matter is transferred to barrels. Another method is to heat the wood in iron retorts, the gaseous products given off being then conducted back to the hearth and burnt, so economising fuel. The tar separates from the watery products on standing, and the latter serve as a source of acetic acid, acetone, methyl alcohol (wood naphtha), etc. Tar is also obtained from the wood of beech, birch, and other trees, but it is not official unless it is prepared from coniferous wood.

**Characters and Tests.**—Tar from wood (specific gravity 1·02 to 1·15) is a dark-brown or blackish semi-liquid substance, with a peculiar aromatic odour and a bitter, pungent taste. It becomes thicker and opaque on keeping, and acquires a granular appearance, owing to the formation of minute crystals of pyrocatechin, resin acids, etc. Water agitated with it acquires a pale brown or yellowish colour, a sharp empyreumatic taste, and an acid reaction which is chiefly due to the presence of acetic acid. Coal tar, on the other hand, imparts an alkaline reaction to water. The filtered aqueous extract of wood tar is coloured red by very dilute (1·0 per cent.) solution of ferric chloride as is also a similar extract of oil of cade, whereas an aqueous extract of birch tar becomes greenish. If stronger (5 per cent.) ferric chloride solution be used, the pine tar water will assume a dark olive-green colour, but the aqueous extract of oil of cade will become olive-brown. Tar is completely soluble in 90 per cent. alcohol or chloroform; it is also soluble in ether or sodium hydroxide solution, and slightly soluble in olive oil or oil of turpentine.

**Notes.**—it is stated that pine tar and beech tar are distinguished from all other kinds by being completely soluble in 95 per cent. acetic acid, and that a petroleum ether extract of pine tar differs from a similar extract of beech tar by the greenish colour it acquires when shaken with a dilute solution of cupric acetate (1 in 1,000); again, French oil of turpentine, chloroform, and absolute ether are said to dissolve pine tar completely, whereas beech tar is not entirely dissolved by those liquids. Tar consists of resinous matter, coloured with charcoal, and mixed with acetic acid, oil of turpentine, and various volatile empyreumatic products. On distillation it yields creosote, an empyreumatic oil called oil of tar, and pyroligneous acid—an impure variety of acetic acid, pitch being left in the retort. The most important constituents of tar are pyrocatechin, phenol, cresol, guaiacol, creosol, phlorol, and methyl-creosol, the last four being present in creosote. Other substances found in wood tar are toluene, xylene, naphthalene, and other hydrocarbons. Coniferous wood yields from 15 to 20 per cent. of tar which is especially rich in guaiacol and its homologues. The wood of beech, birch, and other trees yield only from 6 to 8 per cent. of tar; beech tar is rich in guaiacol and pyrogallol derivatives; birch tar is rich in guaiacol and benzophenol derivatives.

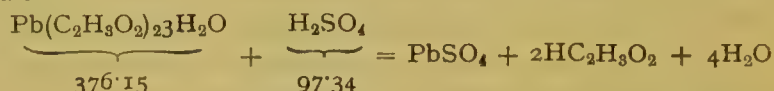
## Plumbi Acetas.

**Lead Acetate**,  $\text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2, 3\text{H}_2\text{O}$ , commonly known as sugar of lead, is obtained by dissolving lead oxide or carbonate in acetic acid and crystallising the resulting solution.

**Characters and Tests.**—Lead acetate occurs in small white monoclinic prisms, slightly efflorescent, having a sweet astringent taste and an acetous odour. This odour is due to the evolution of acetic acid, the salt dissociating into free acetic acid and a basic oxyacetate: the latter is slowly converted into lead carbonate by the action of the carbonic anhydride in the air. It is soluble in less than three parts of cold water, and in 30 parts of 90 per cent. alcohol. Its solution in water slightly reddens litmus, owing to a partial dissociation into



oxysalt and acetic acid, and is clear if the water be free from carbonic acid. As that, however, seldom occurs, the solution is usually slightly milky; this milkiness disappears on the addition of acetic acid, which converts the carbonate into the soluble acetate. Lead acetate affords the reactions characteristic of lead and of acetates and should be free from silver, copper, arsenium, iron, zinc, calcium, sodium, potassium, ammonium, chlorides, and nitrates. One gramme dissolved in water should require for complete precipitation 53.1 C.c. of N/10 volumetric sulphuric acid solution. This test requires that the salt should be practically pure.



Since 1 litre of N/10  $\text{H}_2\text{SO}_4$  solution contains 97.34/20 grammes of  $\text{H}_2\text{SO}_4$  it will be equivalent to  $376.15/20 = 18.8075$  gramme of lead acetate. Each C.c. therefore indicates 0.0188075 gramme and 53.1 C.c. are capable of precipitating  $0.0188075 \times 53.1 = 0.998$  gramme of lead acetate.

[Dose.—1 to 5 grains.]

## Plumbi Carbonas.

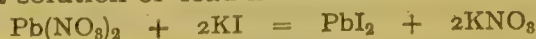
**Lead Carbonate**, as described in the Pharmacopœia, is not the normal carbonate,  $\text{PbCO}_3$ , but a hydroxy-carbonate which is obtained by exposing lead to the action of carbonic anhydride in presence of the vapours of water and acetic acid. Its average composition is represented by the formula  $(\text{PbCO}_3)_2, \text{Pb}(\text{OH})_2$ .

**Characters and Tests.**—Lead carbonate is a soft, heavy, white powder, insoluble in water, entirely soluble in dilute acetic acid. This test indicates absence of several possible adulterants which also occur as heavy white powders, *e.g.*, barium and lead sulphates. It affords the reactions characteristic of lead and of carbonates, and should be free from zinc, calcium, and magnesium.

**Notes.**—Hydroxy-carbonates of lead obtained by the process indicated in the Pharmacopœia, which is known as the Dutch process, are denser than similar compounds obtained by precipitating the solution of a soluble lead salt with sodium carbonate, or passing carbonic anhydride into a solution of basic lead acetate. The Dutch process depends upon the superficial oxidation of the lead plates by exposure to moisture and air. The acetic acid vapours convert the oxide into a film of hydroxy-acetate, and the carbonic anhydride, which is evolved by the fermentation of manure, spent tan, etc., precipitates the hydroxy-carbonate.

## Plumbi Iodidum.

**Lead Iodide**,  $\text{PbI}_2$ , is obtained as a precipitate by adding solution of potassium iodide to a solution of lead nitrate.



Equal quantities of the two salts should be used, and as little water employed as possible, since lead iodide is slightly soluble.

**Characters and Tests.**—Lead iodide is a heavy, bright yellow powder, soluble in about 2,000 parts of cold and in about 200 parts of boiling water, and

deposited in golden-yellow crystalline scales as the latter solution cools. Lead iodide is entirely soluble in solution of ammonium chloride. It affords the reactions characteristic of lead and of iodides, and should be free from nitrates and acetates.

**Notes.**—If, in preparing this salt, the potassium iodide be in excess, it holds a portion of the lead iodide in solution, while an excess, of lead nitrate tends to the formation of insoluble lead oxyiodide.

## Plumbi Oxidum.

**Lead Oxide**, Litharge,  $PbO$ , is prepared by the action of air on melted lead.

**Characters and Tests.**—Lead oxide occurs in heavy scales of a pale yellowish-red colour, completely soluble in dilute nitric acid, forming lead nitrate, and in acetic acid, forming lead acetate. It gives the reactions of lead, and should be free from copper, iron, and carbonates.

**Notes.**—As the oxide slowly absorbs carbonic anhydride from the air, forming carbonate, it should not be kept in fine powder, as this accelerates the rate of formation of carbonate by increasing the surface exposed to the action of the air.

## Podophylli Resina.

**Podophyllum Resin** is a mixture of the active and inert principles of podophyllum rhizome, extracted by exhausting the drug in No. 40 powder with 90 per cent. alcohol and, after recovery of most of the alcohol by distillation, precipitating the residual strong tincture by slowly pouring it, with constant stirring, into distilled water acidulated with one twenty-fourth of its bulk of hydrochloric acid (specific gravity, 1.160), the purpose of the acid being to facilitate the precipitation of the resin in a pulverulent condition.

**Characters.**—Podophyllum resin is an amorphous powder with a bitter taste, and, according to the official description, it varies in colour from pale yellow to deep orange brown, but it would perhaps be more correctly described as varying in colour from greyish-white to pale greenish-yellow or yellowish-green. It turns darker when exposed to a temperature exceeding  $35^{\circ}C$ ., the variations in tint thus appearing to depend upon the heat applied during its preparation. Alum is sometimes used in place of hydrochloric acid to facilitate the subsidence of the resin in a pulverulent condition, and the powder so prepared has a bright yellow colour, besides yielding a larger proportion of ash than the official description allows. The powder should be partly soluble (75 to 80 per cent.) in ether, and almost entirely soluble in 90 per cent. alcohol or in solution of ammonia (specific gravity 0.959), not more than 10 per cent. of insoluble matter being left. Water precipitates the alcoholic, and acids the alkaline, solution. The resin should not yield more than 1 per cent. of ash.

**Notes.**—It has been stated that only the ether-soluble portion of podophyllum resin is therapeutically active. The chief constituent of the resin is about 20 per cent. of an active, neutral, crystalline substance (m.p.,  $117^{\circ}C$ .) named podophyllotoxin,  $C_{15}H_{14}O_6$ , which is converted by hydration

into the salt of an unstable gelatinous acid—podophyllic acid,  $C_{16}H_{16}O_7$ —when heated with alkalis. Podophyllic acid very readily loses water and is converted into its anhydride, picropodophyllin (m.p.,  $227^{\circ}$  C.), which is an inactive, crystalline isomer of podophyllotoxin, and probably the lactone of podophyllic acid. Picropodophyllin can be reconverted into podophyllic acid by heating it with alkalis. Podophyllotoxin and picropodophyllin yield identical decomposition products. Other constituents of podophyllin resin are picropodophyllin, quercetin—a yellow colouring matter also found in quercitron bark—fatty matter, and podophylloresin, an uncrystallisable substance which is said to be the only physiologically active constituent besides podophyllotoxin.

[Dose.— $\frac{1}{4}$  to 1 grain.

## Podophylli Rhizoma.

**Podophyllum Rhizome or Root** consists of the dried rhizome and roots of the may-apple, *Podophyllum peltatum*, Linné (N.O. Berberideæ), a small herbaceous plant indigenous to the eastern United States and Canada. The plant has a long, perennial, creeping rhizome, which is jointed and furnished with roots at the joints. The rhizome, with roots attached, is collected in the late summer, after the leaves have fallen, as it is then supposed to be most efficient. After collection it is dried, shrinking considerably in the process, and is then cut into short pieces.

**Characters.**—Podophyllum rhizome usually occurs in dark reddish-brown nearly cylindrical pieces, about 6 to 18 Cm. long and 5 to 8 Mm. thick. They are nearly smooth or slightly wrinkled longitudinally; if flattened and strongly wrinkled the drug is of poor quality. At intervals of about 5 Cm. or more the rhizome is enlarged and bears on the upper surface of each enlargement a concave scar left by a flowering stem, surrounded by several circular leaf-scars, indicating the position of the cataphyllary leaves. Immediately beneath, on the under surface, occur stout, brittle brown roots, somewhat paler than the rhizome, or scars indicating where they have been. The rhizome is occasionally forked, but produces very few lateral branches. The production of a flowering stem terminates the growth of the main axis of the rhizome, but a bud in the axil of one of the cataphyllary leaves then develops, forming a sympodial system and so continuing the growth of the plant. The dried rhizome breaks with a short and irregular fracture; it is usually whitish and starchy internally, but may appear yellowish-brown and horny if the heat employed to dry the drug has been sufficient to cause the starch to gelatinise. A transverse section exhibits a very thin cork, the cortical layer consisting of a double row of thick-walled yellowish cells enclosed by the epidermis; there are also sixteen or more small, oval, distant fibro-vascular bundles arranged in a circle in a mass of loose parenchymatous tissue. The odour of the drug is characteristic but not strong, being more pronounced when the rhizome is powdered; the taste is at first sweetish, but afterwards bitter and slightly acrid. Ash yield, 3 per cent.

**Notes.**—The distinctive characters of podophyllum rhizome are the straight cylindrical pieces, with occasional stem, leaf, and root scars, and the structure shown by transverse sections. The rhizome of *P. emodi*, Wall., a Himalayan species, is much stouter and more knotty, with an abundance of stout roots.



The medicinal properties of podophyllum rhizome are embodied in the resin or resinoid, commonly known as "podophyllin," of which it yields from 2 to 6 per cent., together with starch and sugar. The rhizome of *P. Emodi* yields from 10 to 12 per cent. of resin; it is said to contain from four to five times as much podophyllotoxin as the American drug, and to be twice as active, physiologically. The yellow colouring matter of both kinds of podophyllum is quercetin.

## Potassa Caustica.

**Potassium Hydroxide** or **Caustic Potash**, KOH, should contain not more than 10 per cent. of combined water and impurities. It is obtained by the action of calcium hydroxide upon a solution of potassium carbonate, the mixture being boiled until a portion of the clear fluid no longer effervesces upon the addition of acid, showing that the soluble potassium carbonate has been converted into hydroxide—



The liquid is then allowed to settle, and the clear portion decanted or siphoned from the deposit of calcium carbonate and calcium hydroxide, since excess of the latter is employed to ensure complete conversion of the potassium salt. Although calcium hydroxide is slightly soluble in water, it is practically insoluble in potassium hydroxide solution, hence none of the excess dissolves. The clear solution is evaporated in iron vessels to a low bulk, the evaporation being completed in silver vessels, and the fused residue poured into moulds or dishes to solidify.

**Characters and Tests.**—Potassium hydroxide occurs in hard white pencils or cakes, very deliquescent, alkaline and corrosive. Soluble in eight-tenths its weight of water and in 2 parts of 90 per cent. alcohol. It affords the reactions characteristic of potassium, and should be free from lead, copper and arsenium. One gramme dissolved in water or alcohol should leave only a trace of sediment, and the solution should require not less than 16.1 C.c. N/1 sulphuric acid solution—

$$\begin{array}{rcccl} 2 \times 55.71 & 97.34 & & & \\ \hline 1,000 \text{ C.c. N/1 H}_2\text{SO}_4 & \text{are equivalent to } 55.71 & \text{grammes KOH.} & & \\ \therefore 1 & \text{"} & \text{"} & \text{"} & .05571 \text{ " "} \\ \therefore 16.1 & \text{"} & \text{"} & \text{"} & .05571 \times 16.1 \text{ " "} \\ & & & & = .897 \text{ " "} \end{array}$$

Since 1 gramme was taken for analysis this is equivalent to 89.7 per cent. KOH.

**Notes.**—As met with in commerce, caustic potash is of very varying degrees of purity. The lower qualities are not suitable for medicinal use, but are employed in technical processes, such as soap making, etc. A very pure variety is that known as "pure by alcohol," which is obtained by treating caustic potash with alcohol and evaporating the filtrate. By this means the hydroxide is separated from potassium carbonate and sulphate, and from other compounds which are insoluble in alcohol.

## Potassa Sulphurata.

**Sulphurated Potash** or **Liver of Sulphur** is a complex mixture of potassium salts, consisting chiefly of sulphide and polysulphides with thiosulphate. It is obtained by fusing 2 parts of dried potassium carbonate with 1 part of sulphur until the evolution of carbonic anhydride ceases. The fused mass is poured out on a slab to solidify and placed as quickly as possible in well-stoppered bottles, since it reacts readily with the moisture and carbonic anhydride of the air. The composition of the product varies with the conditions (*e.g.*, duration and temperature of fusion) under which it has been prepared.

**Characters and Tests.**—Sulphurated potash occurs in solid greenish fragments, liver-brown when recently broken, alkaline and acrid to the taste; readily forming with water a yellow solution which has the odour of hydrogen sulphide, owing to the hydrolytic action of water upon the potassium sulphides, *e.g.*,

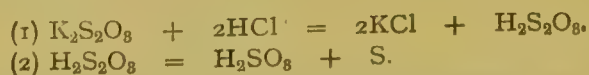


This solution evolves hydrogen sulphide freely upon the addition of hydrochloric acid, sulphur being deposited at the same time owing to the decomposition of the potassium polysulphides and thiosulphate also present. If excess of hydrochloric acid be added, and the liquid boiled to remove  $\text{H}_2\text{S}$ , the filtrate gives with platinic chloride a yellow precipitate, consisting of potassium platino-chloride, and with solution of barium chloride a white precipitate of barium sulphate. About 50 per cent. of sulphurated potash should be soluble in 90 per cent. alcohol, the insoluble portion consisting mainly of carbonate and sulphate, which may be present in excessive proportion through improper manufacture or storage.

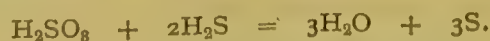
**Notes.**—When the aqueous solution of sulphurated potash is treated with an acid, the evolution of sulphuretted hydrogen indicates presence of sulphides, the deposition of sulphur being due to the presence of polysulphides, such as  $\text{K}_2\text{S}_8$ :—



Thiosulphate of potassium, if present, would be also decomposed with deposition of sulphur, since the free thiosulphuric acid first formed decomposes into sulphurous acid and sulphur:—



**Note** that this deposition of sulphur distinguishes thiosulphates from sulphites, the latter evolving sulphurous anhydride (sulphur dioxide) without deposition of sulphur. The sulphurous acid and sulphuretted hydrogen also react with deposition of sulphur:—



The reaction between those two bodies is very complex, other oxyacids of sulphur—pentathionic acid, for example,  $\text{H}_2\text{S}_5\text{O}_6$ —being formed besides. The facility with which hydrogen sulphide is evolved and finely divided sulphur is

precipitated by these various reactions explains the use of sulphurated potash as a remedy for skin diseases in the form of baths, in which similar decompositions slowly occur owing to the hydrolytic action of the water and the presence of carbonic acid.

## Potassii Acetas.

**Potassium Acetate**,  $\text{CH}_3\text{COOK}$ , or  $\text{KC}_2\text{H}_3\text{O}_2$ , is prepared by neutralising acetic acid with potassium carbonate, and evaporating the solution to dryness; or the residue may be cautiously fused and allowed to solidify.

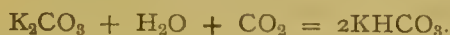
**Characters and Tests.**—Potassium Acetate occurs either in white, foliaceous satiny masses, produced by fusion, or in granular particles produced by evaporation without fusion; very deliquescent, alkaline to litmus, soluble in half its weight of water and in 2 parts of 90 per cent. alcohol. It yields the reactions characteristic of potassium and of acetates, should be free from lead, copper, arsenium, iron, aluminium, calcium, magnesium, carbonates, or sulphides, and contain only traces of chlorides or sulphates.

**Notes.**—It should be observed that although potassium acetate is neutral in composition, its aqueous solution is alkaline. This phenomenon is commonly observed in solutions of salts of strong bases with weak acids, and the reverse phenomenon also occurs in the case of salts of weak bases with strong acids, *e.g.*, copper sulphate, and alum whose aqueous solutions have an acid reaction. This behaviour is probably due to partial hydrolysis of the salts by the water present.

[Dose.—10 to 60 grains.]

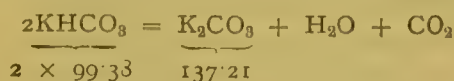
## Potassii Bicarbonas.

**Potassium Bicarbonate**,  $\text{KHCO}_3$ , may be obtained by saturating a strong aqueous solution of potassium carbonate with carbonic anhydride.



Since potassium bicarbonate is much less soluble in water than the carbonate, the former salt crystallises out from the concentrated solution.

**Characters and Tests.**—Potassium bicarbonate forms colourless monoclinic prisms, which are not deliquescent (distinction from carbonate). It possesses a saline feebly alkaline taste, and is soluble in 4 parts of cold water, but almost insoluble in 90 per cent. alcohol. It affords the reactions characteristic of potassium and of bicarbonates; should be free from lead, copper, arsenium, aluminium, calcium, magnesium, sodium, nitrates, sulphides or sulphates, and contain only traces of iron and chlorides. One gramme exposed to a low red heat is converted into a white residue of normal carbonate—



which should weigh 0.69 gramme; for,

$$198.76 : 137.21 :: 1 : 0.6903.$$



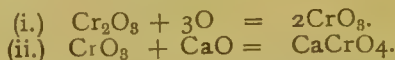
and this residue should require for neutralisation 10 C.c. N/1 sulphuric acid solution—

$$\begin{array}{rcccl} \text{K}_2\text{CO}_3 & + & \text{H}_2\text{SO}_4 & = & \text{K}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2 \\ \hline 137.21 & & 97.34 & & \\ 68.605 \text{ grammes K}_2\text{CO}_3 & \text{are equivalent to} & 1000 \text{ C.c. N/1 H}_2\text{SO}_4. & & \\ \therefore 1 & & & \frac{1000}{68.605} & \\ \therefore .6903 & & & \frac{1000 \times .6903}{68.605} & \\ & & & = 10.06 \text{ C.c.} & \end{array}$$

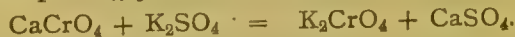
**Notes.**—Twenty parts of potassium bicarbonate are neutralised by fourteen parts of citric acid, or by fifteen parts of tartaric acid. [*Dose.*—5 to 30 grains.]

## Potassii Bichromas.

**Potassium Bichromate**,  $\text{K}_2\text{Cr}_2\text{O}_7$ , or  $\text{K}_2\text{CrO}_4$ ,  $\text{CrO}_3$ , is obtained from chrome ironstone, a naturally occurring substance having the composition  $\text{FeO}$ ,  $\text{Cr}_2\text{O}_3$ . It is, therefore, analogous to magnetic oxide of iron,  $\text{FeO}$ ,  $\text{Fe}_2\text{O}_3$ , in which the  $\text{Fe}_2\text{O}_3$  is replaced by  $\text{Cr}_2\text{O}_3$ . When this chrome ironstone is ground finely, mixed with an alkali, and heated to low redness in a current of air, the chromic oxide takes up oxygen and becomes chromic anhydride,  $\text{CrO}_3$ , which combines with the alkali to form a chromate. The details of the process of manufacture vary, in different works, but lime is usually employed rather than potash or soda, since a porous and less fusible mixture is so obtained which undergoes oxidation more rapidly owing to its porosity. The oxidised product then contains calcium chromate  $\text{CaCrO}_4$ .



According to the official monograph this calcium chromate is then washed out with water and treated with a potassium salt—usually potassium sulphate, which precipitates the sparingly soluble calcium sulphate—



The filtrate is then acidified and the bichromate crystallised out.



Another method is to treat the oxidised product first with sulphuric acid, instead of water, because the calcium chromate, in presence of the excess of lime always employed, is soluble with difficulty in water. By this method the calcium chromate is converted into bichromate,  $\text{CaCr}_2\text{O}_7$ , any iron dissolved by the acid, as well as the excess of acid, being removed by the addition of chalk. The liquid is then treated with potassium sulphate, which precipitates calcium sulphate and leaves potassium bichromate in solution.

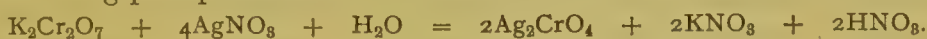
**Characters and Tests.**—Potassium bichromate occurs in large, orange-red, transparent, triclinic crystals, which are soluble in 10 parts of cold water; it fuses below redness; at a higher temperature it is decomposed, yielding green chromium oxide and yellow potassium chromate while oxygen is evolved.



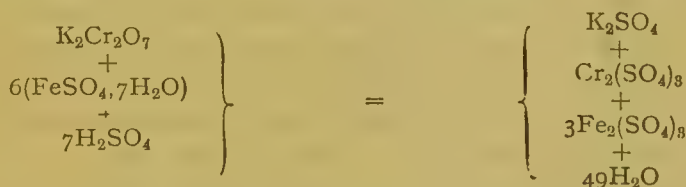
The two solid products of this reaction may be separated by treating the residue with water, in which the potassium chromate is soluble. Aqueous solutions of potassium bichromate give with barium chloride a yellowish-white precipitate of normal barium chromate, the liquid consequently becoming acid—



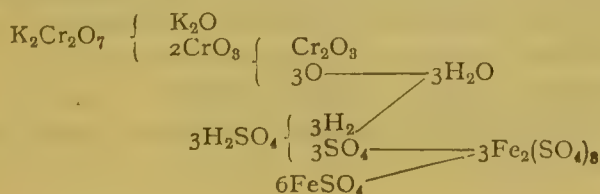
With silver nitrate a corresponding reaction takes place, purplish-red silver chromate being precipitated—



In neither case is the precipitation complete unless the liquid is neutralised, because some of the barium or silver chromate is kept in solution by the liberated acid. Both precipitates are soluble in dilute nitric acid, so that if the bichromate solution be rendered sufficiently acid beforehand no precipitate is obtained by addition of barium chloride or silver nitrate. The solubility of the barium precipitate in dilute nitric acid shows the absence of sulphate in the salt examined, and of the silver precipitate the absence of chloride, since  $\text{BaSO}_4$  and  $\text{AgCl}$  are insoluble in that reagent. The aqueous solution of potassium bichromate digested with sulphuric acid and ethylic alcohol, or with many other organic compounds, acquires an emerald-green colour owing to the oxidation of the organic matter and consequent reduction of the chromium from the condition of oxidation represented by  $\text{CrO}_3$  to the lower stage  $\text{Cr}_2\text{O}_3$ . When these reactions take place in presence of acids the corresponding chromium salts is formed—in the present instance  $\text{Cr}_2(\text{SO}_4)_3$ , which combines with the potassium sulphate, also produced, to form chrome alum: the green colour of the solution is due to this compound. 5.66 grammes of ferrous sulphate, dissolved in a little water acidulated with sulphuric acid, should not cease to yield a blue colour with (freshly prepared) solution of potassium ferricyanide until such a quantity of an aqueous solution of potassium bichromate has been added as contains 1 gramme of the salt. This indicates that the oxidation of the given quantity of ferrous to ferric sulphate has been accomplished by the bichromate according to the following equation—



**Notes.**—The volumetric test with ferrous sulphate requires the bichromate to be practically pure. It depends upon the conversion of ferrous into ferric sulphate, which gives no blue colour with potassium ferricyanide. The reaction and quantitative relationship between potassium bichromate and ferrous salts are best remembered by the aid of the following diagram:—



The diagram shows that one molecule of bichromate is capable of yielding three available atoms of oxygen for oxidising purposes, the  $K_2O$  and  $Cr_2O_3$  forming (in presence of free acid which must be added in order that the reaction may be carried out) the corresponding salts— $K_2SO_4$  and  $Cr_2(SO_4)_3$  with sulphuric acid, or  $2KCl$  and  $Cr_2Cl_6$  with hydrochloric acid. Note also that the free acid is necessary, not only to form salts with the bases, but to enable the ferrous to form the ferric salt, which contains, relatively to the ferrous, a larger proportion of acidulous radical. According to the diagram and equation one molecule of bichromate ( $K_2Cr_2O_7 = 292.3$ ) is capable of converting six molecules of ferrous sulphate ( $6FeSO_4 \cdot 7H_2O = 6 \times 276.10 = 1656.60$ ) into ferric sulphate. From this it follows that 1 gramme of potassium bichromate is capable of oxidising  $1656.60 \div 292.30 = 5.677$  grammes of crystallised ferrous sulphate under the conditions described. A solution of red chromate of potassium in water behaves as if it contained the real bichromate,  $KHCrO_4$ , analogous to other bi- or acid salts like  $KHSO_4$ . When such a solution is crystallised, water is eliminated—



and crystals of the anhydro chromate,  $K_2Cr_2O_7 = K_2CrO_4 \cdot CrO_3$ , are obtained. Analogous anhydro salts are seen in borax,  $Na_2B_4O_7$ ; Nordhausen sulphuric acid,  $H_2S_2O_7 = H_2SO_4 \cdot SO_3$ ; and potassium pyrosulphate,  $K_2S_2O_7 = K_2SO_4 \cdot SO_3$ . The last salt is obtained by strongly heating the acid sulphate, water being eliminated—



The name bichromate is, therefore, strictly speaking, not the best name for the red chromate of potassium. Potassium bichromate in acid solution finds extensive use as an oxidising agent in chemical operations. Sometimes the sodium salt is preferred on account of its greater solubility. Chrome alum produced by the reduction of  $K_2Cr_2O_7$  in presence of sulphuric acid may form either a green or violet solution according to the temperature at which the reaction has been effected, the former colour being produced at higher temperature but the solution changes to a violet colour on long standing. The same phenomenon is shown by many other chromium salts, and appears to be dependent upon the formation of compounds in the green solution in which the chromium forms part of a complex radicle which does not exhibit some of the reactions of normal chromium salts. Most of the chromates of the heavy metals are coloured bodies. When the aqueous solution of potassium bichromate is heated with rectified spirit and sulphuric acid and reduction to green chromium salt occurs, the ethyl alcohol of the rectified spirit is oxidised to aldehyde or acetic acid according to the relative amounts of the substances reacting. This oxidation of ethyl alcohol successively into aldehyde and acetic acid is characteristic of all primary alcohols, that is bodies containing the  $-CH_2OH$  group (compare secondary and tertiary alcohols), each alcohol yielding an aldehyde and acid containing the same number of carbon atoms as itself. Thus ethyl alcohol,  $C_2H_6O$ , yields an aldehyde,  $C_2H_4O$ , and an acid (acetic),  $C_2H_4O_2$ . The empirical formulæ just given serve to show the relationship always existing between a primary alcohol and its corresponding



aldehyde and acid; *i.e.*, when the alcohol is oxidised the first stage is the formation of its aldehyde (*alcohol dehydrogenatum*) accompanied by the removal of two hydrogen atoms by the oxidising agent,  $C_2H_6O - 2H = C_2H_4O$ . The aldehyde by further oxidation passes into the acid, one atom of oxygen being taken up,  $C_2H_4O + O = C_2H_4O_2$ . The constitution and relationship of these three important classes of organic bodies are more fully dealt with in another place. [Dose.— $\frac{1}{10}$  to  $\frac{1}{5}$  grain.]

## Potassii Bromidum.

**Potassium Bromide**, KBr, may be obtained by adding a slight excess of bromine to a strong solution of potassium hydroxide, evaporating the solution to dryness, heating the dry residue with charcoal, and extracting the potassium bromide with water. From this solution it is obtained by crystallisation. When bromine is added to potassium hydroxide solution, potassium bromide and hypobromite are first formed—



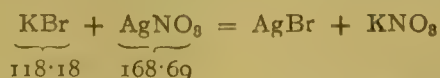
This mixture changes on heating into bromide and bromate:—



The bromate may be converted into bromide (compare action of heat on potassium chlorate) by evaporating the solution and heating the residue; the reduction to bromide is effected more rapidly and at a lower temperature by ignition with excess of carbon—



**Characters and Tests.**—Potassium bromide forms colourless cubical crystals, with no odour, but with a pungent saline taste, soluble in 2 parts of cold water, and in 200 parts of 90 per cent. alcohol. It affords the reactions characteristic of potassium and of bromides, and should be free from lead, copper, arsenium, iron, aluminium, zinc, calcium, magnesium, sodium, ammonium, bromates, iodates, or cyanides, and contain only traces of chlorides, iodides or sulphates. The official monograph states that an aqueous solution of potassium bromide should give no red coloration with solution of ferric chloride, thus showing absence of thiocyanates, which form a dark red ferric compound. It has been shown, however (see *Pharm. Journ.* [4], **12**, 460), that excess of ferric chloride will produce a red coloration (? free bromine) with potassium bromide alone. The red colour in the latter case is intensified by the application of heat and not affected by mercuric chloride, but the red colour of ferric thiocyanate is unaffected by heat and disappears on adding mercuric chloride. One gramme of potassium bromide dissolved in water should require for complete precipitation not less than 83.7 nor more than 85.4 C.c. of N/10 silver nitrate solution. In this test a variation of 1.7 C.c. is allowed in the volume of decinormal silver nitrate solution precipitated by 1 gramme of the salt.



Since, therefore, 11.818 grammes of pure potassium bromide will precipitate

1,000 C.c. of N/10 silver nitrate solution, each gramme of the salt will require  $1,000 \div 11.818 = 84.6$  C.c. of N/10  $\text{AgNO}_3$ . 84.6 is nearly the mean of the minimum and maximum figures—viz., 83.7 and 85.4. Any variation between those limits would probably be due to traces of iodides or chlorides, potassium iodide requiring less and potassium chloride more silver nitrate solution than an equal weight of potassium bromide.

**Notes.**—In the foregoing quantitative test, the presence of moisture in the salt will reduce the quantity of silver nitrate required by any given sample, since it is not directed to dry the salt before weighing. [Dose.—5 to 30 grains.]

## Potassii Carbonas.

**Potassium Carbonate**,  $\text{K}_2\text{CO}_3$ , associated with a variable proportion of water which is equivalent on the average to 16 per cent. of the weight of the salt. The Pharmacopœia states that it is  $\text{K}_2\text{CO}_3$ , associated with either one or two molecules of water. This statement is discussed in the "Notes" (*vide infra*). There are two chief sources of potassium carbonate, (1) wood ashes, (2) native potassium chloride and sulphate. (1) Organic salts of potassium present in vegetable tissues are converted into carbonate when those are incinerated. From the ashes an alkaline product, consisting chiefly of potassium carbonate, may be extracted by water, and the solid residue left by its evaporation is known as pearlash. From this a purer product may be obtained by extraction with a limited quantity of water, since potassium carbonate is far more soluble than most of the mineral substances which occur associated with it in pearlash. A comparatively pure variety is made from the beet residue from which the crystallisable sugar has been removed. This is fermented, and the alcohol separated by distillation. The still-residue is rich in potassium salts, and by evaporation and incineration yields an ash from which potassium carbonate is removed by lixiviation. (2) Native potassium chloride is first converted into sulphate by treating with sulphuric acid,



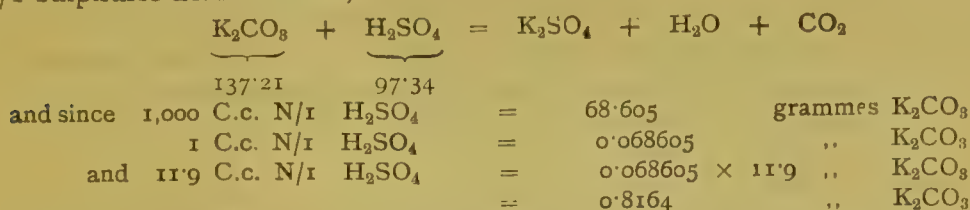
this is mixed with chalk or limestone and coal, and heated in a furnace, when the sulphate is reduced to sulphide, which reacts with the calcium carbonate,



from this product the potassium carbonate is extracted by lixiviation. The process, therefore, is similar to the Le Blanc process for the manufacture of sodium carbonate from salt.

**Characters and Tests.**—Potassium carbonate is a white crystalline powder, alkaline and caustic to the taste, very deliquescent, readily soluble in an equal weight of water, but insoluble in 90 per cent. alcohol. It affords the reactions characteristic of potassium and of carbonates, and should be free from lead, copper, aluminium, calcium, magnesium, sodium, cyanides, nitrates, sulphates, sulphides, and thiosulphates. It may contain small traces of iron, and may (and usually does) contain distinct traces of

chlorides. One gramme should require for neutralisation at least 11.9 C.c. of N/1 sulphuric acid solution,

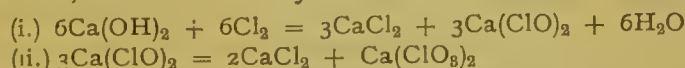


which is equivalent to 81.64 per cent. purity. Two grammes after exposure to a red heat should leave between 1.66 and 1.7 grammes of anhydrous potassium carbonate,  $\text{K}_2\text{CO}_3$ , corresponding to a loss of 15 to 17 per cent. of water.

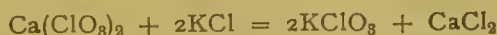
**Notes.**—The official statement as to the water of crystallisation is incorrect, for a salt containing two molecules of water,  $\text{K}_2\text{CO}_3, 2\text{H}_2\text{O}$ , should lose 20.67 per cent. of moisture when heated to redness. The formula  $\text{K}_2\text{CO}_3, \text{H}_2\text{O}$  corresponds to 11.53 per cent. water, while the salt  $\text{K}_2\text{CO}_3, 1\frac{1}{2} \text{H}_2\text{O}$  which has been obtained by the crystallisation of cold solutions contains 16.35 per cent. water, *i.e.*, between the required limits. Since, however, potassium carbonate is obtained by evaporating its solutions to dryness and not by crystallisation the commercial product is partly dehydrated. [*Dose.*—5 to 20 grains.]

## Potassii Chloras.

**Potassium Chlorate**,  $\text{KClO}_3$ , is obtained by passing chlorine into water holding lime or magnesia in suspension. A mixture of chloride and hypochlorite is thus formed, and the latter passes into chloride and chlorate on warming. Thus, with calcium hydroxide—



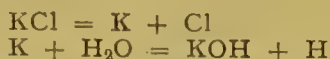
Both calcium chloride and chlorate are very soluble salts, and on adding a solution of potassium chloride to the liquid, potassium chlorate, which is much less soluble, crystallises out—



Potassium chlorate can be obtained by the direct action of chlorine on solution of potassium hydroxide; but, as may be seen from the equations above, only five-sixths of the base employed is eventually obtained as chlorate. It is therefore more economical to employ the cheaper calcium hydroxide (slaked lime) in the first stage, and afterwards add the more valuable potassium salt, all of which is then converted into chlorate. Potassium chloride, from the natural deposits occurring in Germany, is usually employed for this purpose. An electrolytic process is also employed, chiefly in Switzerland and Sweden, where water-power is available for the production of electrical energy. In this process a solution of potassium chloride is electrolysed, the fluid being kept at about 80° C., and constantly stirred, so that the products formed at the two electrodes are brought into contact. The potassium chloride is decomposed primarily into potassium and chlorine. The potassium, however, undergoes a secondary reaction when it is liberated at the kathode, by which hydrogen is



liberated and potassium hydroxide formed. The chlorine, which is liberated at the anode, then reacts with the KOH producing KCl and KClO<sub>3</sub>, the former salt being again available for electrolysis, while the potassium chlorate may be crystallised out when the amount produced has reached the necessary concentration. The following equations represent these reactions—



Hydrogen gas therefore escapes, while the potassium hydroxide reacts with the chlorine forming chloride and hypochlorite. At the temperature at which the electrolysis is carried out (80° C.), the hypochlorite passes rapidly into chloride and chlorate.



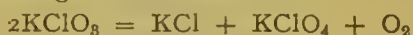
Since the potassium chloride (which is regenerated to the extent of  $\frac{5}{6}$  the original quantity decomposed) may be again electrolysed, the whole of the potassium is theoretically convertible into chlorate. The initial and final stages may be summed up in the following equation—



**Characters and Tests.**—Potassium chlorate occurs in colourless, monoclinic crystals, with a cool saline taste, soluble in 17 parts of cold water, and 2 to 3 parts of boiling water. Moistened with hydrochloric acid, it evolves a yellow gas, consisting of a mixture of chlorine and chloric oxide, ClO<sub>2</sub>. The chlorine is formed by the mutual reaction of the chloric and hydrochloric acids, thus—



while the chloric oxide is produced by a secondary decomposition of the chloric acid. When heated, potassium chlorate fuses and gives off oxygen, potassium chloride and perchlorate being first formed.



The whole of the oxygen is only evolved at a high temperature, since potassium perchlorate is not decomposed at the melting point of potassium chlorate. If certain substances, *e.g.*, ferric oxide or manganese dioxide, be mixed with the potassium chlorate, then the whole of the oxygen is given off at the lower temperature according to the equation—



In any case, after oxygen has been evolved the residue will contain KCl, and its aqueous solution will yield the reactions characteristic of chlorides. Potassium chlorate should be free from lead, iron, aluminium, calcium, magnesium, sodium, or nitrates, and contain only traces of chlorides or sulphates.

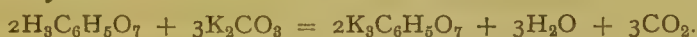
**Notes.**—In order to produce a solution of chlorine, as a powerful deodorant and disinfectant gargle, potassium chlorate and hydrochloric acid are often prescribed together. For this purpose the strong hydrochloric acid is poured over the powdered salt in a loosely corked bottle, which becomes filled in a few minutes with a mixture of chlorine and chloric oxide. Water is then added in successive portions, and the bottle well shaken between each addition, so as to dissolve the gases. The chloric oxide, with the water, produces a

mixture of chlorine oxyacids, *e.g.*,  $\text{HClO}$  and  $\text{HClO}_2$ , which are capable eventually of yielding free chlorine by decomposition. If the salt be dissolved in water and the acid added, *i.e.*, if dilute hydrochloric acid be employed, the formation of chlorine proceeds very slowly. This milder form, however, is often employed as a gargle, where the action of the undecomposed chlorate is desired, in association with only traces of free chlorine.

[*Dose.*—5 to 15 grains.

## Potassii Citras.

**Potassium Citrate**,  $\text{K}_8\text{C}_6\text{H}_5\text{O}_7$  or  $\text{C}_3\text{H}_4\cdot\text{OH}\cdot(\text{COOK})_3$ , is prepared by neutralising a solution of citric acid with potassium carbonate and evaporating the solution to dryness.



As the salt thus prepared contains a molecule of water, which can only be expelled by heating to 200° C., its formula is more correctly given as  $\text{K}_3\text{C}_6\text{H}_5\text{O}_7 \cdot \text{H}_2\text{O}$ .

**Characters and Tests.**—Potassium citrate is a white powder of saline feebly acid taste, deliquescent, very soluble in water. It affords the reactions characteristic of potassium and citrates. It should be free from lead, iron, calcium, magnesium, sodium, carbonates and tartrates, and contain only traces of chlorides or sulphates. One gramme of the dried salt, heated to redness until gases ( $\text{CO}$  and  $\text{CO}_2$ ) cease to be evolved, should leave an alkaline residue of potassium carbonate (mixed with carbon) which, when treated with water, filtered to remove carbon, and well washed, should yield a clear solution requiring for neutralisation at least 9.7 C.c. of normal sulphuric acid. Since—

$$\underbrace{\text{K}_8\text{C}_6\text{H}_5\text{O}_7}_{304.11} \text{ is equivalent to } \underbrace{1\frac{1}{2}\text{K}_2\text{CO}_3}$$

and that is equivalent to 98.33 per cent. purity. But pure commercial potassium citrate, containing one molecule of water, corresponds to only 94.45 per cent. of the anhydrous salt.

**Notes.**—In the titration test the filtrate from the ignited product should be not only clear but colourless. Any brown tint indicates insufficient ignition, and consequently incomplete formation of carbonate, and the result of the titration will be too low. [*Dose.*—10 to 40 grains.]

# Potassii Iodidum.

**Potassium Iodide**, KI, may be prepared in the same manner as potassium bromide, iodine being used in place of bromine. It is also prepared by treating iron with iodine and water to form a solution of ferrous iodide—



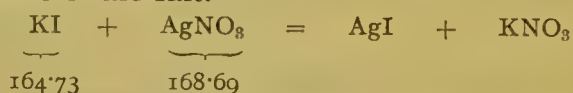
adding a solution of potassium carbonate to the ferrous iodide solution, and

crystallising the filtrate obtained after separation of the precipitate of ferrous carbonate—



**Characters and Tests.**—Potassium iodide occurs in colourless, generally opaque, cubic crystals, soluble in less than its own weight of cold water, and in 12 parts of 90 per cent. alcohol. It commonly has a feeble alkaline reaction. It affords the reactions characteristic of potassium and of iodides. It should be free from lead, copper, arsenium, iron, aluminium, calcium, magnesium, sodium, ammonium, bromates, iodates, cyanides, and nitrates, and contain only the slightest traces of bromides, chlorides, carbonates, or sulphates. One gramme dissolved in water should require not less than 59.5 and not more than 61.9 C.c. of N/10 silver nitrate solution for complete precipitation.

**Notes.**—The Pharmacopœia gives a minimum and maximum figure for the quantity of N/10 silver nitrate solution required for the complete precipitation of 1 gramme of the salt.



16.473 grammes of pure potassium iodide require, therefore, 1 litre of N/10 solution of silver nitrate.

$$\therefore 1 \text{ gramme KI} = \frac{1000}{16.473} = 60.70 \text{ C.c. N/10 AgNO}_3.$$

60.70 is the mean of 59.5 and 61.9. If titration of the salt yields results outside the Pharmacopœia limits, it indicates on the one hand presence of more than traces of chlorides and bromides, which require more silver nitrate for complete precipitation than an equal weight of iodide, owing to their lower molecular weights. If the volume of silver nitrate falls below the minimum value given, then presence of more than traces of impurities having no action on silver nitrate are indicated. Potassium iodide is often the subject of incompatibility in prescriptions, and the pharmacist should, therefore, always carefully consider this possibility in dispensing the salt. The incompatibility generally arises from the liberation of iodine by accompanying substances, and is dangerous, because the action of free iodine is entirely different and more powerful—particularly locally—than the same quantity of iodine as iodide. Iodine is easily liberated from potassium iodide by many oxidising agents, those most often met with in prescriptions being nitrous acid in spirit of nitrous ether, and ferric chloride in Liquor Ferri Perchloridi. [Dose.—5 to 20 grains.

## Potassii Nitras.

**Potassium Nitrate**,  $\text{KNO}_3$ , also known as nitre or saltpetre, was formerly obtained entirely from the crude nitre formed in the soil by the action of certain bacteria. These are able to convert the nitrogen of decaying organic matter into nitric acid, and that combines to form nitrates with the alkaline bases present in the soil. This formation of nitrates was afterwards carried out by making a mixture of manure, or other refuse, with marl, chalk, or building rubbish, and exposing the mixture in heaps which were moistened from time to



time with sewage. The nitrifying bacteria then converted the ammoniacal nitrogen of the organic matter into nitrates, the necessary oxygen being obtained from the air. By lixiviating with water (adding potassium carbonate, if necessary, to convert calcium and magnesium nitrates into the potassium salt) a solution of potassium nitrate could be obtained and the product purified by recrystallisation. Since the appearance of the native sodium nitrate (Chili saltpetre) and the native potassium chloride, much of the potassium nitrate of commerce has been obtained from those sources, and its preparation affords a good example of the separation of compounds by crystallisation under different conditions. If solutions of sodium nitrate and potassium chloride be mixed, the mixture contains four different salts, viz.,  $\text{KCl}$ ,  $\text{NaCl}$ ,  $\text{KNO}_3$ , and  $\text{NaNO}_3$ . By concentrating this solution at its boiling point the sodium chloride first reaches its solubility limit, because it is hardly more soluble in hot than cold water. The other three salts are, however, more soluble in hot water. Hence under those conditions the hot solution becomes first saturated in regard to the sodium chloride, which crystallises as the concentration proceeds and is separated. When the sodium chloride has been thus partly separated, the liquid is cooled and then potassium nitrate separates, because its solubility at low temperature is less than those of the other salts. Moreover, since sodium and chlorine as  $\text{NaCl}$  have been partly removed from it, the relative proportion of potassium nitrate has been increased according to the equation—



and hence on this account, as well as its lesser solubility, potassium nitrate separates from the cooled liquid.

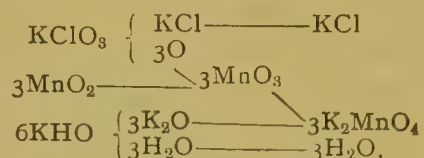
**Characters and Tests.**—Potassium nitrate occurs in white crystalline masses or fragments of striated six-sided rhombic prisms, colourless, having a cool saline taste. It is soluble in 4 parts of cold water or in half its weight of boiling water. It affords the reactions characteristic of potassium and of nitrates, but should be free from lead, copper, arsenium, iron, aluminium, zinc, calcium, magnesium, sodium, ammonium, chlorates, chlorides, iodides and sulphates.

**Notes.**—Formation of small crystals of potassium nitrate is promoted by rapid stirring of the solutions during cooling: these are more easily separated from adherent mother liquid. If allowed to crystallise without disturbance large crystals are formed, and these often include portions of the mother liquor in their interior. The potassium nitrate obtained in small crystals is known as “saltpetre flour” and is purified by recrystallisation. Sal prunelle is a mixture of potassium nitrate and sulphate, prepared by fusing the nitrate in a crucible, then adding sulphur, and pouring out the fluid mass to cool. The sulphur is partly oxidised to sulphate by the potassium nitrate. [*Dose.*—5 to 20 grains.]

## Potassii Permanganas.

**Potassium Permanganate**,  $\text{KMnO}_4$ , may be produced by the oxidation of manganese dioxide,  $\text{MnO}_2$ , in presence of potassium hydroxide, and conversion of the potassium manganate so produced into the permanganate by treatment with water. In making this salt the black oxide,  $\text{MnO}_2$ , is usually

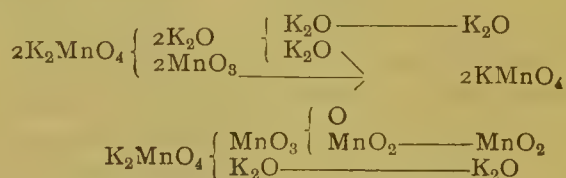
oxidised by potassium chlorate, the mixture of manganese dioxide, potassium hydroxide and chlorate being heated to fusion. The reaction may be regarded as the conversion of the dioxide to manganic anhydride,  $\text{MnO}_3$ , which combines with the potassium oxide to form the green manganate. The oxidation may be effected slowly, without the chlorate, through the abstraction of oxygen by the fused mass from the air.



When the fused mass, which is green from the presence of potassium manganate, is boiled in water the green colour changes to red, and the solution becomes alkaline, while a precipitate of hydrated manganese dioxide is formed. The formation of the dioxide is due to mutual oxidation and reduction, one portion of the manganate being oxidised to permanganate at the expense of another, which is thereby reduced to the dioxide. To simplify the explanation of this change remember that  $\text{MnO}_3$ , manganic anhydride, becomes permanganic anhydride,  $\text{Mn}_2\text{O}_7$ —



Since manganic acid is dibasic, while permanganic acid is monobasic, some of the potassium appears as hydroxide—

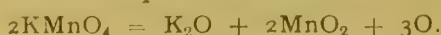


The  $2\text{K}_2\text{O}$  shown in the above equation forms potassium hydroxide by combination with water. By comparing the formulæ of manganates and permanganates it will be seen that the manganic and permanganic radicles have the same formula,  $\text{MnO}_4$  ( $\text{K}_2\text{MnO}_4$  and  $\text{KMnO}_4$ ), but the former is bivalent and the latter univalent. The formulæ for the corresponding anhydrides are consequently

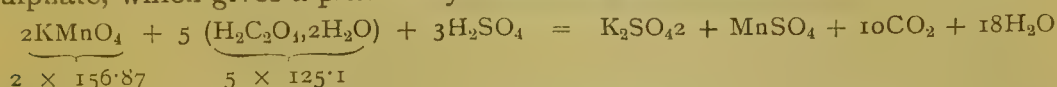


which explains why the *per*-manganates are so called in relation to the manganates. The permanganate of potassium, formed by boiling the manganate solution, is re-converted into manganate of potassium at a certain stage of concentration if the alkaline solution containing the free potassium hydroxide be evaporated. Before attempting to crystallise, therefore, the hydroxide of potassium is converted into carbonate by a current of carbon dioxide (or sulphate by neutralising with sulphuric acid).

**Characters and Tests.**—Potassium permanganate forms dark, slender, purple, prismatic, iridescent crystals, with a sweet astringent taste, soluble in 20 parts of cold water, neutral to litmus. The crystals heated to redness decrepitate and are decomposed with evolution of oxygen, leaving a black residue of manganese dioxide and potassium oxide—



This residue treated with water yields a solution of potassium hydroxide. Potassium permanganate should be free from lead, arsenium, iron, aluminium, calcium, magnesium, sodium, ammonium, carbonates, chlorides and sulphates. One gramme dissolved in water and acidulated with 5 C.c. diluted sulphuric acid should require for complete decolorisation 31.2 C.c. of an aqueous solution containing 62.58 grammes of pure crystallised oxalic acid per litre. This volumetric test is based upon the oxidation of oxalic acid to carbon dioxide and water, the highly coloured permanganate being converted into manganese sulphate, which gives a practically colourless dilute solution—



The oxalic acid solution referred to in the official test as containing 62.58 grammes of oxalic acid per litre is probably meant to be the normal solution, which contains 62.55 grammes per litre *i.e.*,  $\frac{1}{2}(\text{H}_2\text{C}_2\text{O}_4, 2\text{H}_2\text{O})$ , the molecular weight of oxalic acid according to the table of atomic weights given in the B.P. appendix being 125.1. Assuming this to be so, it will be seen from the equation that 313.74 grammes of potassium permanganate will require for decolorisation 10 litres of normal oxalic acid solution,

$$\therefore 1 \text{ gramme KMnO}_4 \text{ will require } \frac{10,000}{313.74} \text{ C.c. N/1 oxalic acid solution} = 31.87 \text{ C.c.}$$

The potassium permanganate is therefore by this test required to be 97.9 per cent. pure, because

$$31.2 : 31.87 :: 97.9 : 100$$

**Notes.**—The behaviour of potassium manganate and permanganate towards water should be carefully noted. The manganate is stable in alkaline, the permanganate in acid solutions. Potassium permanganate is used very extensively as an oxidising agent in chemical operations, and its oxidising capacity is different in neutral or alkaline and acid solutions. In the former case 2KMnO<sub>4</sub> yield three atoms of oxygen, the manganese being precipitated as dioxide—usually in a hydrated condition, *i.e.*, combined with water—while the potassium appears as hydroxide—



In acid solution the reduction of the permanganate is carried a stage lower, and consequently five instead of three atoms of oxygen are available—



The oxide, MnO, is not precipitated, like the MnO<sub>2</sub>, but reacts with the acid present to form the corresponding manganese salt, *e.g.*,



and a clear solution results. This explains why volumetric titrations with permanganate are carried out in presence of acid, since, in the clear solutions obtained under those conditions, the pink tint of excess of permanganate is at once visible when the reaction is completed. Moreover, the oxidation reactions in acid solutions are more definite and quickly completed. The formula

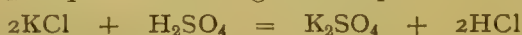


$K_2Mn_2O_8$  given in the Pharmacopœia is not correct. Investigations of solution of potassium permanganate by electrolytic and other methods leads to the formula,  $KMnO_4$ , which is moreover confirmed by the isomorphism of permanganates and perchlorates,  $MCIO_4$ . [Dose.—1 to 3 grains.]

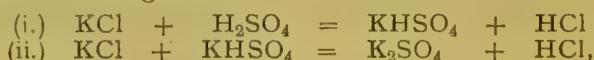
## Potassii Sulphas.

**Potassium Sulphate**,  $K_2SO_4$ , may be obtained by purifying the native sulphate; it is also obtainable by the action of sulphuric acid on many other potassium salts, and is produced in this way in the manufacture of potassium carbonate from native potassium chloride (*vide* Potassii Carbonas).

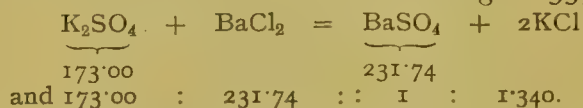
**Characters and Tests.**—Potassium sulphate occurs in colourless, hard, rhombic prisms, terminated by six sided pyramids; it decrepitates when strongly heated. The salt is soluble in 10 parts of cold water and 4 parts of boiling water. It affords the reactions characteristic of potassium and of sulphates and should be free from lead, copper, arsenium, iron aluminium, zinc, calcium, magnesium, sodium, ammonium, or nitrates, and contain only traces of chlorides. Its aqueous solution should have no action on litmus, which will become red if any acid sulphate,  $KHSO_4$ , be present through incomplete realisation of the reaction—



This really occurs in two stages—



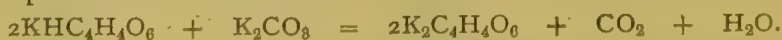
and the second stage requires a much higher temperature than the first for its completion. 1 gramme dissolved in water and acidulated with hydrochloric acid gives, with barium chloride solution, a white precipitate of barium sulphate, which when washed and dried should weigh 1.339 grammes—



**Notes.**—In the foregoing quantitative test the precipitation is best accomplished by adding the barium chloride to the acidulated solution of potassium sulphate heated to its boiling point, since the barium sulphate is then precipitated in a granular condition and is easily removed by filtration. It is usual to incinerate the washed barium sulphate, as this is more expeditious than weighing the dried precipitate in a tared filter. Care must be taken to avoid reduction of barium sulphate to sulphide by contact with the carbonised filter paper. The precipitate is therefore partly dried and detached from the paper, which is ignited separately, and its ash added afterwards to the main portion of the barium sulphate. [Dose.—10 to 40 grains.]

## Potassii Tartras.

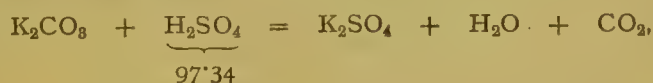
**Potassium Tartrate**, the official formula for which is  $(CHOH)_2(COOK)_2 \cdot H_2O$ , or  $K_2C_4H_4O_6 \cdot H_2O$ , is obtained by neutralising acid potassium tartrate with potassium carbonate—



The neutral tartrate crystallises with half the proportion of water shown by the

official formula, which is incorrect. It should be one molecule of  $\text{H}_2\text{O}$  for two molecular weights of tartrate—*i.e.*,  $(\text{K}_2\text{C}_4\text{H}_4\text{O}_6)_2, \text{H}_2\text{O}$ , or more simply,  $\text{K}_2\text{C}_4\text{H}_4\text{O}_6, \frac{1}{2}\text{H}_2\text{O}$ . The latter formula may be used, although it contains half a molecule of water, because the formula is only intended to show the simplest relationship of the water in the crystalline salt, and not the molecular formula of potassium tartrate in the state of vapour, since its molecular weight cannot be determined in this manner.

**Characters and Tests.**—Potassium tartrate occurs in small colourless four or six-sided prisms. It is soluble in its own weight of cold water, and affords the reactions characteristic of potassium and of tartrates. It should be free from lead, copper, iron, and carbonates, and contain not more than traces of calcium, magnesium, sodium, chlorides, or sulphates. Since the salt is made from the acid tartrate and is so soluble in water it is practically impossible to purify it by crystallisation from the traces of impurities referred to. One gramme of the dry salt, heated to redness, should leave an alkaline residue of potassium carbonate, mixed with more or less carbon. This residue when heated with water, filtered to remove carbon, and well washed should yield, according to the official monograph, a filtrate requiring for exact neutralisation 8.4 C.c. of normal sulphuric acid solution. In this test for purity the salt by ignition is converted into carbonate, like the alkali salts of all organic acids, and  $\text{K}_2\text{C}_4\text{H}_4\text{O}_6$  is equivalent to  $\text{K}_2\text{CO}_3$ . The excess of carbon is partly burnt off as carbon monoxide and dioxide and partly left behind as charcoal. The charred mass when lixiviated with water and filtered should yield a colourless solution of potassium carbonate. Any trace of yellow or brown colour indicates insufficient incineration, and consequently incomplete conversion of the tartrate into carbonate. The results yielded by the titration of a coloured solution will be, therefore, always too low. Since one molecule of tartrate, according to the B.P. formula ( $\text{K}_2\text{C}_4\text{H}_4\text{O}_6, \text{H}_2\text{O} = 242.46$ ), yields one molecule of carbonate, which is capable of neutralising one molecule of sulphuric acid ( $\text{H}_2\text{SO}_4 = 97.34$ )—



it follows that 242.46 grammes of tartrate having the formula given in the Pharmacopœia, after incineration, will yield an alkaline solution equivalent to 2,000 C.c. normal solution of sulphuric acid (N/1 sulphuric acid solution contains  $\frac{1}{2}\text{H}_2\text{SO}_4 = 48.67$  grammes per litre). From this it follows that one gramme—the quantity given in the official test—will be equivalent to

$$\frac{2000}{242.46} = 8.25 \text{ C.c. of N/1 sulphuric acid solution.}$$

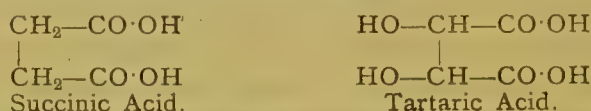
Unless the salt contains some free potassium carbonate before incineration, it cannot therefore yield more alkali than is sufficient to neutralise 8.25 C.c. N/1 sulphuric acid solution. The discrepancy between this figure, 8.25, and the number of C.c. given in the Pharmacopœia, *viz.*, 8.4, is due to the employment of an incorrect formula. As stated above, neutral potassium tartrate crystallises with only half the water stated in the Pharmacopœia. The molecular equiva-

lent then becomes 233.52, and one gramme of the salt, if pure, will, after incineration, neutralise—

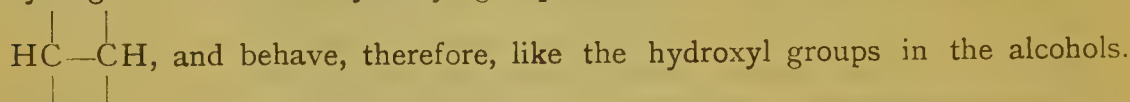
$$\frac{2000}{233.52} \text{ C.c. N/1 sulphuric acid solution} = 8.56 \text{ C.c.}$$

The aqueous solution of potassium tartrate should not redden litmus, showing absence of acid potassium tartrate.

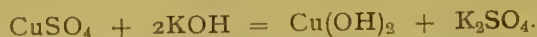
**Notes.**—The constitutional formula given in the Pharmacopœia is intended to show that tartaric acid is di-oxy-succinic acid.



It will be seen that the acid contains four hydroxyl groups, but only two are readily replaceable by bases, *i.e.*, the acid is dibasic. This serves to show how the properties and behaviour of an element are influenced by its environment. For the two replaceable hydrogen atoms are those of the hydroxyl groups associated with the —CO— or carbonyl groups, which are strongly electro-negative. The close proximity of these negative groups causes the hydrogen to be readily interchangeable with metals which are more electro-positive than hydrogen. The other hydroxyl groups are connected with the basic residues



Certain metals, however, *e.g.*, copper and iron, have the property of forming complex compounds with tartrates and other organic salts and acids which contain alcoholic hydroxyl groups, and in these compounds the metals do not give many of the reactions of their ordinary salts. This is believed to be due to the replacement of the hydroxylic hydrogen by the metals, which are therefore present as constituents of a complex acidulous radical and not as the basylous radical, as in their ordinary salts. Thus, when potassium hydroxide is added to an aqueous solution of cupric sulphate the corresponding hydroxide is precipitated—



When, however, potassium tartrate is added, the cupric hydroxide is redissolved, with formation of a soluble potassium cupro-tartrate—



Compare the formation and reactions of the scale compounds of iron, solution of bismuth and ammonium citrate, and Fehling's solution.

[Dose.—30 to 40 grains.]

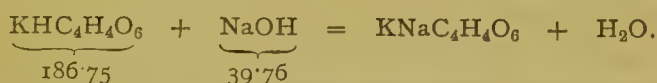
## Potassii Tartras Acidus.

**Acid Potassium Tartrate**,  $\text{KHC}_4\text{H}_4\text{O}_6$ , is commonly known as Cream of Tartar. It is obtained by recrystallising the crude cream of tartar which is deposited during the fermentation of grape juice in the production of wine, the



acid tartrate being precipitated because it is less soluble in alcohol than in water. Consequently, as fermentation proceeds, and the proportion of alcohol in the liquor increases, the solubility limit of the acid tartrate is exceeded and a deposit gradually forms, which consists chiefly of acid potassium tartrate with some calcium tartrate. That is decolorised by treatment with charcoal, clay, etc., and purified by recrystallisation from hot water.

**Characters and Tests.**—Acid potassium tartrate occurs as a gritty white powder, or as fragments of cakes crystallised on one surface, with an acid taste. It is soluble in about 200 parts of cold water, more soluble in hot water and insoluble in strong alcohol. It affords the reactions characteristic of potassium and of tartrates, should be free from lead, copper, and iron, and contain only traces of calcium, magnesium, sodium, chlorides and sulphates. One gramme of the dry salt when quite pure neutralises 5.35 C.c. of normal sodium hydroxide solution.



∴ 186.75 grammes  $\text{KHC}_4\text{H}_4\text{O}_6$  neutralise 1000 C.c. N/1 NaOH solution.

∴ 1 g amme  $\text{KHC}_4\text{H}_4\text{O}_6$  neutralise  $\left( \frac{1000}{186.75} \right)$  C.c. N/1 NaOH solution.  
= 5.35 C.c.

The official test states that not less than 5.2 C.c. of normal soda solution should be required for the neutralisation of 1 gramme. This accords very closely with the presence of not more than 2.5 per cent. of impurities, which may consist of moisture and neutral salt—chiefly calcium tartrate and sulphate, which do not neutralise any sodium hydroxide during titration.

**Notes.**—The slight solubility of the acid tartrate is utilised as the basis of an analytical reaction for the detection of potassium. The delicacy of the reaction is diminished by one or two factors, the conditions of which must be thoroughly understood before the test can be used intelligently. It should be noted, in the first place, that when tartaric acid is added to the solution of a neutral potassium salt, an equivalent amount of free acid is produced from the acidulous radical with which the potassium was previously combined—

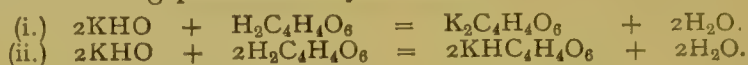


This free acid (particularly if a mineral acid) exerts a solvent action on the acid tartrate, and prevents its precipitation in weak solutions. The reaction becomes, therefore, more delicate if sodium hydrogen tartrate,  $\text{NaHC}_4\text{H}_4\text{O}_6$ , be employed in place of tartaric acid, since a neutral sodium salt is then formed in place of free acid. Compare the following equation with the preceding one—



It is now obvious that if the solution to be tested is not neutral but already contains free acid, the delicacy of the tartrate test for potassium is still more reduced. From this it follows that the solution, if acid, should be neutralised by addition of sodium hydroxide or carbonate (not ammonium, because that base also forms an insoluble acid tartrate). On the other hand, the presence of free

alkali may interfere with the reaction, if sufficient tartaric acid or acid sodium tartrate be not added to produce a distinctly acid reaction, because the neutral potassium tartrate is freely soluble in water, and if only enough reagent be added to produce that, no precipitate results. Consider the following equations for a solution containing potassium hydroxide—



Acid tartrate of potassium also exhibits the phenomenon of super-saturation—that is, water will retain in solution, for a time, more of the salt than corresponds with its actual solubility. Such super-saturated solutions only slowly deposit the excess of dissolved substance; hence, in dilute solutions, precipitation only occurs after standing some time, but it may be hastened by stirring or shaking. Formation of the precipitate is also accelerated by the addition of alcohol to the test mixture. Since most other metals also form insoluble tartrates, the test can only be appropriately applied after the removal of all the bases except sodium—a procedure which is, of course, adopted in the ordinary schemes of qualitative analysis. This test has been discussed rather fully in order to show the necessity for knowing always, not only the reagents which produce certain reactions, but also the conditions under which the reactions produce the proper result. [Dose.—20 to 60 grains.

## Pruni Virginianæ Cortex.

**Wild Cherry Bark**, incorrectly named “Virginian Prune Bark,” is obtained from the wild black cherry, *Prunus serotina*, Ehrhart (N.O. Rosaceæ), a tree widely distributed throughout North America. Bark is collected indiscriminately from all parts of the tree, but that obtained from the root or branches is believed to be superior to that from the trunk. The reason for collecting it in the autumn is that it is understood to be most active then; it should also be preferred recently dried, as it deteriorates on keeping.

**Characters.**—Wild cherry bark occurs in curved or flattened pieces, or in fragments of irregular shape, about 2 Mm. or more in thickness; they may be as much as 12 Cm. long and 5 Cm. broad, but are generally much smaller. Young bark is frequently covered with a smooth and sometimes glossy, reddish-brown cork, which is thin, papery, and marked with numerous, transversely elongated, whitish lenticels, but the cork is sometimes absent in specimens of the commercial drug. When present, it is easily peeled off in thin membranous strips, and then discloses the greenish-brown cortex, which bears scars corresponding to the lenticels. If the cortex should also have been removed, as in the case of old bark, the exposed surface consists of the outer layer of bast, which is usually rough and of a nut-brown or dark cinnamon-brown colour; when examined under a lens such bark exhibits pale longitudinal strands (sclerenchymatous cells) alternating with darker parenchymatous tissue (medullary rays). The inner surface of the bark is cinnamon-brown in colour and finely striated or fissured longitudinally, or it may be reticulated and rough, the interstices between the pale bast fibres being only partially filled

with the brown parenchymatous tissue of the medullary rays. The bark breaks with a short reddish-grey, granular fracture, and the fractured surface exhibits numerous groups of sclerenchymatous cells of characteristic irregular shape, which are contained in the bast rays that alternate with the tortuous, pale-red medullary rays. The astringency of the drug is due to the tannin it contains; the aromatic, bitter taste is caused by the formation of benzaldehyde when the bark is chewed, and to the presence of a bitter glucoside. The slight odour, which is much more apparent when the drug is macerated in water, resembles that of bitter almonds when similarly treated.

**Notes.**—The official English name for this bark is a misnomer; the tree from which it is obtained is more properly known as the wild black cherry, and must not be confused with the choke cherry, *P. virginiana*, Linné, the inner bark of which has a somewhat disagreeable odour. Wild black cherry bark yields benzaldehyde, dextrose, and from 0.075 to 0.16 per cent. of hydrocyanic acid when macerated in water, owing to the hydrolysis of pruserotin (lævo-mandelonitrile glucoside), an isomer of prulaurasin and sambunigrin; the particular ferment, to the action of which the hydrolysis is due, appears to be allied to, if not identical with, emulsin or synaptase. The bark obtained from young trees is said to contain more glucoside than that from older ones, and the bark from the root has been stated to yield most hydrocyanic acid, whilst that from the twigs and branches yields more than bark from the trunk. Other constituents of the bark are benzoic, paracoumaric, and trimethylgallic acids, volatile oil, sugar, tannin, and green and brown resins from which a phytosterol, fatty acids, and  $\beta$ -methylæsculetin can be obtained; the green resin also yields the alcohol ipuranol, and the brown resin yields dextrose.

## Prunum.

**Prunes** are the dried ripe fruits of *Prunus domestica*, Linné, var. *Juliana*, De Candolle (N.O. Rosaceæ), a variety of the plum tree cultivated in France, especially in the valley of the Loire. The fresh fruit (*Prune de Saint-Julien*) is an oval or ovoid drupe nearly 2.5 Cm. long, and of a deep violet colour. After collection the fruits are partly dried in an oven, and then exposed to the heat of the sun until quite dry. The dried fruit is imported from the South of France.

**Characters.**—Prunes are of irregular, flattened-ovoid or oblong shape, about 3 Cm. long, with a shrivelled, nearly black surface and a faint agreeable odour. The sarcocarp or brownish pulp has no marked odour, but a sweet and bland acidulous taste; it should be soft and fleshy, surrounding a hard oval flattened stone, which is broadly rounded at one end and marked at the other with a shallow, slightly oblique depression, the putamen or shell being smooth or irregularly ridged. The seed is like an almond, but smaller, and has a taste like that of the bitter almond.

**Notes.**—Other dried plums which are occasionally substituted for prunes, or “French plums,” as they are sometimes called, have stones differing in shape from those of the latter. Only the pulp of prunes is used in medicine, being extracted by boiling the fruits with distilled water and then straining out



the stones and epicarps; it contains about 40 per cent. of dextrose, 2 per cent. of vegetable acids (malic, tartaric, etc.), and 30 per cent. of water, together with mucilaginous matter, etc. The seed of the prune contains fixed oil, amygdalin, and emulsin (synaptase), hydrocyanic acid being formed when they are crushed in the presence of water, as in the case of bitter almonds.

## Pterocarpī Lignum.

**Red Sanders Wood**, also known as red sandal wood, is the heart-wood of *Pterocarpus santalinus*, Linné filius (N.O. Leguminosæ), a native of India, which is also found in Ceylon and the Southern Philippines. It grows best in mountainous districts, and is cultivated in Southern India, where the wood is a staple article of produce. The wood is imported from Madras and Ceylon in heavy, irregular, roundish or angular billets or logs of varying size and thickness, from which the rugged bark and pale sapwood have been removed. The red colour of the wood, which is used simply as a colouring agent, is due to a resinous colouring matter which is found in the wood fibres, wood parenchyma, and vessels of the heart-wood.

**Characters.**—Red sanders wood is imported in large heavy logs which are dark reddish-brown or blackish-brown externally, but of a deep blood-red colour when freshly cut, a transverse section exhibiting alternate dark and lighter zones. The medullary rays are just visible when the wood is examined under a lens, whilst the vessels are seen to be large, mostly isolated, and connected by fine, bright red lines of wood parenchyma. The wood is hard, but easily split, and is usually seen in the form of coarse powder or small hard splintery raspings, of a deep blood-red to dark reddish-brown or dull purplish-red colour, according to the time which has elapsed since the wood was rasped. The wood is practically odourless, but it exhales a faint aroma when warmed; its taste is very slightly astringent. The red colouring matter is soluble in 90 per cent. alcohol, ether, acetic acid, and alkaline solutions, also in the oils of lavender and rosemary; it is only sparingly soluble in cold water and the wood does not colour the saliva red when chewed. Ash-yield, 1 to 2 per cent.

**Notes.**—Other woods of similar appearance to red sanders wood differ as regards the solubility of their colouring matter. That of red sanders wood—santalin or santalic acid—is a red, crystalline, resinous substance, which is precipitated from alkaline solutions on adding acids. It is insoluble in water, but yields a red solution with alcohol, the resulting tincture giving a deep violet precipitate with ferrous sulphate, a scarlet precipitate with mercuric chloride, and a violet precipitate with salts of lead. Alkaline solutions of santalin are of a deep red or violet colour, but on precipitating a solution in potassium hydroxide with hydrochloric acid, a colourless crystalline principle named “santal” can be extracted from the precipitate. Santal forms colourless scales, an alcoholic solution of which assumes a deep red colour on the addition of ferric chloride. Pterocarpin and homo-pterocarpin are names which have been applied to other colourless crystalline principles said to have been obtained from red sanders wood.

## Pulveres.

**Powders.**—The official “Powders” may be broadly divided into two classes (1) those representing a combination of several drugs, the use of which in this form is indicated by the result of medical experience, and (2) those in which a potent drug is diluted by the addition of comparatively innocuous substances, also in the form of powder. There are two “powders” which are not employed for their medicinal effects, but as aids in dispensing—viz., compound powders of almond and of tragacanth. Several of the “powders” are employed as purgatives, and others as astringents. In both cases aromatic and carminative drugs enter into their composition with a view to allaying discomfort caused by the irregular peristaltic action in the intestines which gives rise to griping pains.

**Pulvis Amygdalæ Compositus.** COMPOUND POWDER OF ALMONDS.

A mixture of blanched and dried sweet almonds, rubbed to a coarse powder, with powdered sugar and gum acacia. The powder is used for suspending insoluble remedies which it is desired to administer in mixture form. The almonds must be thoroughly dried in a cloth after blanching, as they can then be rubbed to a smoother consistence, and the resulting powder keeps better. When rubbed down with an aqueous vehicle the powder forms a smooth bland milky fluid, the formation of which is due to the emulsification of the almond oil by the gum.

**Pulvis Antimonialis.** ANTIMONIAL POWDER.

This is a dilution of antimonious oxide with calcium phosphate. The latter has no importance as a remedial agent in association with the antimonious oxide, and in the doses in which the powder is administered. Its use is, however, due to the fact that the official formula is an imitation of an old nostrum which was said to be composed of those two constituents. It is sometimes known as Pulvis Jacobi or James' Powder, from the name of the physician who introduced the powder into medicinal use. [Dose.—3 to 6 grains.

**Pulvis Catechu Compositus.** COMPOUND POWDER OF CATECHU.

Is a mixture of three astringent drugs—catechu, kino, and rhatany root, with two aromatics, cinnamon bark and nutmeg. There is no reason other than long established usage for the combination of those three tannin-containing drugs. [Dose.—10 to 40 grains.

**Pulvis Cinnamomi Compositus.** COMPOUND POWDER OF CINNAMON.

Is a combination of the three aromatics, cinnamon, cardamoms, and ginger, also known as Pulvis Aromaticus. It is sometimes employed as a carminative adjunct to pills. [Dose.—10 to 40 grains.

**Pulvis Cretæ Aromaticus.** AROMATIC POWDER OF CHALK.

A combination of prepared chalk, with the aromatics, cinnamon, nutmegs, cloves, and cardamoms, sweetened by the addition of sugar. It is often prescribed in the form of a mixture, and should then first be rubbed to a

smooth paste with a little of the vehicle. In this case there is no need to add gum to suspend the chalk, since the powdered tissues of the drugs present form a viscid liquid with water by virtue of the mucilaginous constituents almost universally found in vegetable tissues.

[Dose.—10 to 60 grains.

**Pulvis Cretæ Aromaticus cum Opio.** AROMATIC POWDER OF CHALK WITH OPIUM.

A mixture of 1 of opium with 39 of aromatic powder of chalk.

[Dose.—10 to 40 grains.

**Pulvis Elaterini Compositus.** COMPOUND POWDER OF ELATERIN.

A mixture of 1 part elaterin with 39 parts milk sugar, the object of the dilution being chiefly to bring the dose of the preparation within the limits which can be safely and expeditiously weighed by means of ordinary dispensing scales.

[Dose.—1 to 4 grains.

**Pulvis Glycyrrhizæ Compositus.** COMPOUND POWDER OF LIQUORICE.

A combination of senna and sublimed sulphur, flavoured and sweetened with fennel fruit, liquorice root, and sugar.

[Dose.—5 to 15 grains.

**Pulvis Ipecacuanhæ Compositus.** COMPOUND POWDER OF IPECACUANHA.

This powder is known as "Dover's Powder," after the name of its originator; it contains 1 part opium, 1 part ipecacuanha, and 8 parts potassium sulphate. This combination of the two drugs, opium and ipecacuanha, is much employed in medical treatment, while the potassium sulphate, by virtue of its dry, non-hygroscopic nature, forms a convenient medium for their dilution. In the usual doses of the compound powder, however, the potassium sulphate can have but little medicinal action, and its employment in the present case is traceable to the original formula for the combination.

[Dose.—5 to 15 grains.

**Pulvis Jalapæ Compositus.** COMPOUND POWDER OF JALAP.

A mixture of jalap and acid potassium tartrate with the carminative, ginger. The addition of the acid tartrate improves the action of the jalap as a purgative in certain cases, causing the expulsion of much water.

[Dose.—20 to 60 grains.

**Pulvis Kino Compositus.** COMPOUND POWDER OF KINO.

A mixture of kino, 5 per cent. of opium, and cinnamon.

[Dose.—5 to 20 grains.

**Pulvis Opii Compositus.** COMPOUND POWDER OF OPIUM.

This powder contains 10 per cent. of opium with black pepper, ginger, caraway fruit, and tragacanth. The combination is an old-established one.

[Dose.—2 to 10 grains.

**Pulvis Rhei Compositus.** COMPOUND POWDER OF RHUBARB.

A combination of rhubarb with an antacid and purgative, light magnesia, and a carminative, ginger. If a less bulky preparation be desired heavy magnesia may be employed, but it should be observed that the use of magnesium carbonate is not allowed. The preparation is commonly known as "Gregory's Powder."

[Dose.—20 to 60 grains.



**Pulvis Scammonii Compositus.** COMPOUND POWDER OF SCAMMONY.

Scammony resin and jalap mixed with a carminative, ginger.

[Dose.—10 to 20 grains.

**Pulvis Sodæ Tartaratae Effervescens.** EFFERVESCENT TARTARATED SODA POWDER.

This is commonly known as "Seidlitz Powder"; it consists of 120 grains tartarated soda and 40 grains sodium bicarbonate mixed and wrapped in blue paper, and 38 grains tartaric acid, in powder, wrapped in white paper. When the alkaline powder is dissolved in about half-a-pint of water and the tartaric acid added an effervescent saline draught is produced having a slightly acid taste. This is due to the quantity of acid employed being slightly in excess of the quantity required (35.6 grains) to form neutral tartrate of sodium with the sodium bicarbonate. The slight excess of acid is intentionally ordered because a slightly acid saline draught has a more agreeable taste than one which is neutral or alkaline.

**Pulvis Tragacanthæ Compositus.** COMPOUND POWDER OF TRAGACANTH.

A mixture of tragacanth with gum acacia, starch, and sugar. It is chiefly used to impart viscosity to "mixtures" in order to suspend insoluble substances, and is more convenient to use than simple tragacanth powder, because the particles of tragacanth being separated by the other constituents are less apt to form clotty lumps when the powder is rubbed down with water.

[Dose.—20 to 60 grains.

## Pyrethri Radix.

**Pyrethrum Root** is obtained from *Anacyclus Pyrethrum*, De Candolle (N.O. Compositæ), a small plant with a perennial root, which is a native of the Levant, Barbary, and the Mediterranean coast of Europe. Pellitory root, as it is usually termed, is collected in the autumn, chiefly in Algeria, and dried.

**Characters.**—Pyrethrum root usually occurs in simple unbranched pieces, about 12 Mm. in thickness, and varying from 5 to 10 Cm. or more in length. The pieces are nearly cylindrical in shape, tapering towards the tip and frequently also towards the crown, where a tuft of grey or nearly colourless hairs is often to be found. The outer surface of the root is brown and deeply and irregularly wrinkled longitudinally. The root is tough and breaks with a short fracture; a transverse section shows that the bark is closely adherent to the wood, which exhibits a prominently radiate structure, wide whitish medullary rays alternating with narrow yellowish wedges of vascular tissue. Scattered yellow or brown ducts or glands containing oleo-resin are to be seen in the medullary rays and bark or cortex. When cut the roots appear of a horny nature, rather than starchy or fibrous. It has a characteristic though not strong odour, which is probably due to the presence of volatile oil. The peculiar taste of the drug is due to the presence of pyrethrine, fixed oils, and resin; it is slight at first, but afterwards acidulous, saline and acrid.

The drug also causes a burning and tingling sensation in the mouth and throat, and excites a copious flow of saliva. Ash-yield, 4 to 6 per cent.

**Notes.**—The distinctive characters of pyrethrum root are the radiate structure of the wood, the wide medullary rays, and the presence of numerous glands or ducts. Belladonna root, which somewhat resembles it, has no glands and should contain starch; dandelion root has a small yellow wood and a thick, whitish, ringed bark; liquorice root has a sweet taste, but no glands, and has much narrower medullary rays. Pyrethrum root contains an acrid resin and two acrid fixed oils, together with tannin, gum, inulin, a little volatile oil, and various salts, but its active principle is a crystalline alkaloid named pyrethrine or pellitorine, which possesses an intensely pungent taste and is said to split up like piperine when treated with alcoholic potassium hydroxide, yielding piperidine and pyrethric acid as the products of its decomposition. The name "pyrethrin" has been given to a mixture of the resin and fixed oils.

## Pyroxylinum.

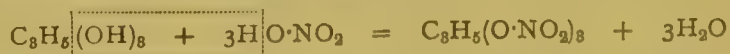
**Pyroxylin** is produced by immersing 1 part of cotton (so-called cotton-wool) in a mixture of 5 parts each, by measure, of sulphuric and nitric acids. After three minutes' immersion, with constant stirring, the product is removed from the acids, and rapidly and thoroughly washed with water until free from acid, drained, and dried on a water bath.

**Tests.**—Pyroxylin is readily soluble in a mixture of equal volumes of ether and 90 per cent. alcohol. On ignition it burns rapidly, and should leave no residue of mineral impurities.

**Notes.**—The directions for making pyroxylin, as given in the Pharmacopœia, are intended to effect the formation of di-nitrocellulose. This is soluble in a mixture of alcohol and ether, while the mono- and tri-nitro derivatives (produced by shorter and more prolonged treatment respectively with nitric acid) are insoluble. The employment of sulphuric acid in this process is an example of an important use to which this body is applied in chemical reactions, viz., the removal of water (with which it combines) produced during the reaction. The accumulation of the water in the reaction mixture would otherwise weaken the nitric acid and check the nitration of the cellulose, which is only accomplished by strong nitric acid. Just as water is produced in the formation of metallic nitrates by the action of nitric acids upon hydroxides, thus—



so in the formation of esters of nitric acid (organic salts of nitric acid), from the hydroxyl derivatives of hydrocarbons (alcohols) and nitric acid, water is similarly produced. For example, in the case of nitro-glycerin—



and in the case of cellulose, which from its chemical behaviour and near

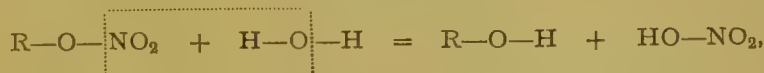
relationship to the sugars (see Notes under *Saccharum Purificatum*) is believed to contain several hydroxyl groups, water is also formed when nitric acid esters are produced by the action of nitric acid—



Note that the formula for cellulose is sometimes written  $(\text{C}_6\text{H}_{10}\text{O}_5)_n$ , for the molecular formula is undoubtedly some multiple of  $\text{C}_6\text{H}_{10}\text{O}_5$ . The value of  $n$  cannot be found by any of the ordinary methods of molecular weight determination, because the vapour density of cellulose cannot be determined, and it is not soluble, without decomposition, in any solvent. Its molecular weight cannot therefore be found by any of the methods employed for substances in solution (alteration of boiling and freezing point, osmotic pressure, etc.), but attempts have been made to find its value by a study of the products obtainable by the hydrolysis of cellulose. Although the products of the nitration of cellulose are commonly called nitro-celluloses, it would be more correct to describe them as cellulose nitrates. The prefix nitro- is used to indicate compounds (of which nitro-benzene is a familiar example) containing the  $\text{NO}_2$  group, the nitrogen being linked directly to the carbon of the nucleus  $\text{R}-\text{NO}_2$ . Such nitro-bodies are not easily hydrolysed, and when reduced they yield amines, *e.g.*, nitro-benzene yields aniline—



Both these reactions indicate that nitrogen connected directly with the carbon is not easily removed. The nitrated celluloses, on the other hand, behave like esters of nitric acid, *i.e.*, they contain  $\text{NO}_2$  groups linked, not directly, but through an oxygen atom to the carbon of the nucleus: thus  $\text{R}-\text{O}-\text{NO}_2$ . As a consequence of this method of linkage both hydrolysis and reduction easily effect the separation of the  $\text{NO}_2$  group, thus—



nitric acid being regenerated. The products of reduction are not so simple. The original alcoholic body  $\text{R}-\text{O}-\text{H}$  is, however, obtained, and various products resulting from the reduction of the  $\text{NO}_2$  group. In order to avoid confusion in nomenclature, it should also be noted that the empirical formula for cellulose,  $\text{C}_6\text{H}_{10}\text{O}_5$  is sometimes written  $(\text{C}_{12}\text{H}_{20}\text{O}_{10})_n$ , the figures being doubled and the value of " $n$ " being probably high. The formulæ for the cellulose mono-, di-, and tri-nitrates (commonly called nitro-celluloses), become  $\text{C}_{12}\text{H}_{18}(\text{O}\cdot\text{NO}_2)_2\text{O}_8$ ,  $\text{C}_{12}\text{H}_{16}(\text{O}\cdot\text{NO}_2)_4\text{O}_6$ , and  $\text{C}_{12}\text{H}_{14}(\text{O}\cdot\text{NO}_2)_6\text{O}_4$ , if doubled, and the compounds should then be called cellulose di-, tetra-, and hexa-nitrate respectively. The reason for thus doubling the formula is based chiefly upon the production of penta derivatives, such as cellulose penta-nitrate,  $\text{C}_{12}\text{H}_{15}(\text{O}\cdot\text{NO}_2)_5\text{O}_5$ , for which the half formula is clearly inadmissible.

## Quassia Lignum.

**Quassia Wood** is obtained from the trunk and branches of *Picræa excelsa*, Lindley (N.O. Simarubææ), a lofty tree found in Jamaica and the Caribbean



Islands. It is imported in logs and billets which are commonly covered with a thin, smooth, dusky grey or blackish, readily separable bark, which is white and fibrous within. Surinam quassia wood, from *Quassia amara*, was the kind originally used in medicine, but it is not now official in this country.

**Characters.**—Quassia wood is imported in logs of varying length, which frequently exceed 15 Cm. in diameter, but may be much smaller. The wood is yellowish-white, tough, dense, and easily split. It is usually seen in the form of splinters, chips, or raspings. When examined with a lens, a longitudinal section of the wood appears transversely striated by reason of the small vertical height of the medullary rays, and exhibits elongated cells (wood parenchyma) containing single crystals of calcium oxalate. In a smooth and moistened transverse section numerous medullary rays, mostly two or three cells in width, can be seen traversing somewhat irregular concentric rings which simulate annual rings, but are the result of the distribution of parenchyma in more or less concentric bands. The vessels usually occur in groups of two or three, and frequently extend from one medullary ray to the next. Quassia wood has no odour, but its taste is intensely bitter. Ash-yield, about 4 per cent.

**Notes.**—Certain dark grey or blackish markings or patches sometimes exhibited by quassia wood are due to the mycelium of a fungus, the dark coloured hyphæ of which penetrate the cells of the wood parenchyma and medullary rays, sometimes forming delicate patterns. Jamaica quassia, as it is termed, is distinguished by the width of the medullary rays and the presence of crystals of calcium oxalate. Surinam quassia is usually in smaller billets than Jamaica quassia; in addition, it has medullary rays which are usually only one cell wide, and the wood parenchyma is free from crystals of calcium oxalate. The activity of Jamaica quassia appears to be chiefly due to three crystalline bitter principles, two of which— $\alpha$ -picrasmin and  $\beta$ -picrasmin—are closely allied, if not homologous, and are said to yield picramic acid when hydrolysed with hydrochloric acid; they differ in melting point and solubility, as also does the third bitter principle. The name “quassin” is given to a mixture of  $\alpha$ - and  $\beta$ -picrasmin. A yellow, crystalline substance present in the wood, which exhibits a blue fluorescence in acidulated alcoholic solutions, is believed to be of alkaloidal nature. Other constituents of the wood are mucilage, pectin, and resin; it is free from tannin. Surinam quassia contains quassiins, closely allied or homologous, crystalline, bitter principles which differ in melting point and solubility, and have higher melting points than the picrasmins, which they closely resemble. The quassiins are also said to yield quassic acid when hydrolysed with hydrochloric acid, the resemblance to the picrasmins being thus even more strongly marked.

## Quillaia Cortex.

Quillaia or Panama Bark is obtained from *Quillaja saponaria*, Molina (N.O. Rosaceæ), a native of Chili and Peru. The tree has very hard wood and a thick bark which is removed in large pieces, freed from the outer, dark-coloured portion, and dried.

**Characters.**—Quillaia bark is usually imported in large flat pieces, about 4 Mm. thick, 60 Cm. or more long, and from 10 to 15 Cm. wide. The outer surface is longitudinally striated and of a pale brownish-white or yellowish-white colour, with reddish-brown or blackish-brown streaks, where the outer portion of the bark has been imperfectly removed. The pieces appear of a uniform dull dark-red colour, and, if insufficiently trimmed, have patches of the outer bark adhering to them. The inner surface is smooth and white or yellowish-white. The bark breaks with a splintery fracture, and the fractured surface tends to separate into thin laminæ or plates. The freshly exposed laminated surfaces and the smooth inner surface of the bark exhibit glistening prismatic crystals of calcium oxalate, especially when examined with a lens, and a smoothed transverse section is seen to be marked with fine radial and tangential lines, which give it a chequered appearance. The radial lines are medullary rays and the tangential bands consist of bast parenchyma, the darker portions enclosed by the lines consisting of groups of bast fibres. The drug has no marked odour, but fine particles dislodged from it are extremely irritating to the nostrils and induce prolonged fits of sneezing. The taste of the bark is astringent and acrid. The sternutatory effects and acrid taste are due to the glucosides present. Ash-yield, 8 to 14 per cent.

**Notes.**—The distinctive characters of quillaia bark are its very smooth inner surface, splintering laminated fracture, and the presence of glistening crystals of calcium oxalate. Elm bark (*Ulmus campestris*), which somewhat resembles it, is fibrous and has a roughish inner surface, while slippery elm bark (*Ulmus fulva*) is very fibrous and has a decided odour of fenugreek. The name "soap bark" has been applied to quillaia bark because water in which it has been macerated froths like soap solution when agitated. The frothing effect is caused by two colourless, amorphous, acrid, toxic glucosides—quillajic acid and quillaja-sapotoxin, the active constituents of the bark. Commercial "saponin" is stated to consist of a mixture of those two substances with inert matter, including a carbohydrate named lactosin and, frequently, an inert modification of quillajic acid, produced during the process of manufacture. Other constituents of the bark are cane sugar, starch, gum, and various salts, but it contains neither tannin nor any bitter principle. Quillaja-sapotoxin and quillajic acid closely resemble, but are not identical with, senegin and polygalic acid (*vide* Senegæ Radix) respectively. Quillajic acid yields quillaja-sapogenin, galactose, and a non-fermentable, dextro-rotatory sugar on hydrolysis. It should be noted that the saponin class includes various bodies which can be arranged in a homologous series; thus, quillaja-sapotoxin  $C_{17}H_{26}O_{10}$ , digitonin or saporubin,  $C_{19}H_{28}O_{10}$ , quillajic acid,  $C_{19}H_{30}O_{10}$ , cyclamin or sarsaparill-saponin,  $C_{20}H_{32}O_{10}$ , sarsa-saponin,  $C_{22}H_{36}O_{10}$ , parillin,  $C_{26}H_{44}O_{10}$ .

## Quininæ Hydrochloridum.

**Quinine Hydrochloride**, formerly called quinine hydrochlorate,  $C_{20}H_{24}N_2O_2 \cdot HCl \cdot 2H_2O$ , is obtained by neutralising the quinine from the bark

of various species of *Cinchona* and *Remijia* with hydrochloric acid and crystallising the product.

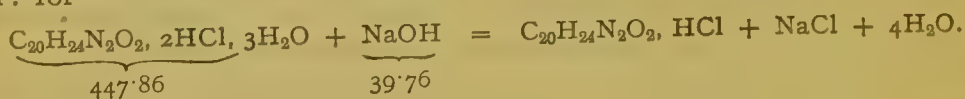
**Characters and Tests.**—Quinine hydrochloride forms crystals which resemble those of the sulphate, but are usually larger. It is soluble in 35 parts of cold water, in 3 parts of 90 per cent. alcohol, and much more soluble in those fluids when hot. It yields the reactions characteristic of hydrochlorides, and should contain only traces of sulphate. When dissolved, together with an equal weight of sodium sulphate, in ten times its weight of hot water and the mixture set aside to cool, double decomposition occurs, and the more sparingly soluble quinine sulphate is deposited in small crystals. This deposit, collected on a filter and washed with water, should respond to the more detailed characters and tests given in the monograph of Quininæ Sulphas. Those tests, so far as they deal with the presence of other cinchona alkaloids in the quinine salt, are based upon a method of fractional crystallisation which can be applied more advantageously to the alkaloidal sulphates than to the hydrochlorides; hence the preliminary conversion of quinine hydrochloride into sulphate. Dried at a temperature of 100° C. quinine hydrochloride loses its water of crystallisation, this loss corresponding to 9 per cent.

**Notes.**—The quinine hydrochloride is used in preference to the sulphate in some cases, on account of its greater solubility. [Dose.—1 to 10 grains.

## Quininæ Hydrochloridum Acidum.

**Acid Quinine Hydrochloride**,  $C_{20}H_{24}N_2O_2$ ,  $2HCl$ ,  $3H_2O$ , may be obtained by dissolving quinine in an excess of hydrochloric acid and crystallising the salt therefrom; or by double decomposition between quinine sulphate and barium chloride in presence of hydrochloric acid.

**Characters and Tests.**—Acid quinine hydrochloride is a white crystalline powder, soluble in less than its own weight of water, and yielding a solution having an acid reaction. It affords the reactions characteristic of hydrochlorides and should contain only traces of sulphate. One gramme dissolved in 20 C.c. of water should require for its complete neutralisation not more than 2.5 C.c. of normal sodium hydroxide solution, thus showing that the salt does not contain appreciably more hydrochloric acid than corresponds to the formula given: for—



In testing this salt for purity it is first converted into the sulphate in a manner similar to that described for the neutral hydrochloride except that the reaction mixture is neutralised with ammonia, so that the sulphate of the official composition shall be deposited. Dried at 100° C., it should not lose more than 12 per cent of water.

**Notes.**—This acid hydrochloride is serviceable on account of its solubility in water, since this enables one to prepare strong solutions suitable for hypodermic injection. [Dose.—1 to 10 grains.



## Quininæ Sulphas.

**Quinine Sulphate**  $[(C_{20}H_{24}N_2O_2)_2, H_2SO_4]_2, 15H_2O$ , is the sulphate of an alkaloid obtained from various species of *Cinchona* and *Remijia*. The total alkaloids may be partly extracted from the bark by treatment with acidulated water, and precipitated from the liquor by the addition of sodium hydroxide. By dissolving the precipitate in sulphuric acid, neutralising with an alkali, and bleaching with charcoal, the quinine sulphate may be separated from the solution of mixed sulphates by fractional crystallisation, since it is much less soluble in water than are the sulphates of the accompanying alkaloids. This process, however, is never carried out on a manufacturing scale.

**Characters and Tests.**—Quinine sulphate occurs in small, white crystals, which have an intensely bitter taste. It is soluble in about 800 parts of cold water, forming a blue, fluorescent solution, though the fluorescence is not so pronounced as in the case of acidulated solutions. The sulphate is more soluble in hot water, the excess readily crystallising as the solution cools; the salt is also readily dissolved by dilute mineral acids, forming soluble acid salts. Aqueous solutions of quinine sulphate give a white precipitate of the alkaloid on adding solution of ammonia, drop by drop, the precipitate redissolving in excess of the reagent, or in ether when that fluid is agitated with the liquid in which the alkaloid is suspended. Aqueous solutions of quinine salts treated with solution of bromine or of chlorine, and then with ammonia, assume a fine emerald green colour (thalleioquin reaction) which changes to red when mineral acids are added. If the mineral acid be very dilute and is added drop by drop to the green liquid, the colour will be seen to change to blue when the fluid is neutral, and then to red when excess of acid is added. Quinine sulphate effloresces when exposed to dry air, and finally attains a constant composition when it contains two molecules of water of crystallisation (*vide* Notes); 2.5 grammes of the freshly prepared salt should lose 0.38 gramme of water by drying at 100° C., corresponding closely to the proportion of water (15.3 per cent.) shown in the official formula. Quinine sulphate having that formula is efflorescent, hence the loss shown by samples taken from stock is usually less than that indicated. When incinerated, it should leave no ash, showing absence of fixed mineral impurities. Quinine sulphate, when tested by the following methods, should not give any appreciable indication of the presence of cinchonine, quinidine, cupreine, or amorphous alkaloid, and should not yield more than a total of 3 per cent. of crystals of impure cinchonidine when examined by the process given below. Those tests are discussed fully in the notes at page 399.

**TEST FOR CINCHONIDINE AND CINCHONINE.**—Dissolve 4 grammes of quinine sulphate in 120 C.c. of boiling water. Cool the solution slowly to 50° C., with frequent stirring to facilitate the separation of pure quinine sulphate, the cinchonidine sulphate, which is more soluble, being left in the mother liquor. Filter to remove the crystals, and concentrate the filtrate by evaporation, until it measures 10 C.c. or less. Concentration of the filtrate renders the test more effectual in detecting the cinchonidine. Transfer the

concentrated liquid to a small, stoppered flask or bottle, and shake, when cold, with 10 C.c. of ether, and 5 C.c. of solution of ammonia. Set aside in a cool place for not less than twenty-four hours, to allow the portion insoluble in the ether to separate completely. Collect the crystals, which consist of cinchonidine—and cinchonine, if there be any—combined with quinine, on a tared filter, wash with a little ether to remove the adherent ethereal liquor (which contains quinine), dry at 100° C., and weigh. The crystals should not weigh more than 0.12 gramme, corresponding to 3 per cent. of impurity in the quinine sulphate. This test depends upon the fractional crystallisation of the salt, which concentrates the more soluble cinchonidine sulphate in the filtrate. When ammonia is added to that, the alkaloids are precipitated and dissolve on the addition of ether, the crystals of impure cinchonidine or other insoluble alkaloid crystallising out from the ethereal solution on standing for twenty-four hours. When certain of the cinchona alkaloids are crystallised out from an ethereal solution, they form stable crystalline compounds with one another, and in the present instance the crystals which separate are composed of cinchonidine and quinine. The test, as described in the Pharmacopœia, is defective, and might be improved in several ways, as explained in the notes at page 399.

TEST FOR QUINIDINE.—Dissolve 1 gramme of quinine sulphate in 30 C.c. of boiling water, cool, and filter to remove the crystals of quinine sulphate. To the filtrate, which will contain a small quantity of quinine sulphate together with the more soluble sulphates of cinchonidine and quinidine which may be present, add solution of potassium iodide and a little 90 per cent. alcohol, to prevent the precipitation of the hydriodides of alkaloids other than quinidine (not only “amorphous” alkaloids, as officially stated). Any quinidine present will be precipitated as the very sparingly soluble hydriodide, the corresponding salt of quinine and cinchonidine being more soluble. Collect any precipitate which may appear, wash with a little water, dry, and weigh. The weight represents about an equal weight of crystallised quinidine sulphate, the molecular weights of this salt and of the hydriodide being nearly the same. None or only the slightest traces should be obtained.

TEST FOR CUPREINE.—Cupreine sulphate is very sparingly soluble in water, and it will therefore be found, if present, in the recrystallised salt obtained in the first operation already described under the “Test for Cinchonidine.” Shake this recrystallised quinine sulphate with 25 C.c. of ether and 6 C.c. of solution of ammonia. The quinine and cupreine are precipitated and dissolve in the ether. Separate the ethereal solution and add to it the ethereal liquid and washings also obtained in the previous test for cinchonidine, because these may contain a portion of any cupreine present in the original salt. Shake the united ethereal liquids with 6 C.c. of a 10 per cent. solution of sodium hydroxide, adding water if any solid matter should separate. This effects the separation of cupreine which passes into the soda solution, leaving the quinine in the ether. Cupreine appears to possess a phenolic hydroxyl group, and hence, like phenols (ordinary phenol, guaiacol, eugenol, etc.), forms a water-soluble compound with the alkali



hydroxides. The alkaline aqueous layer, after separation, is washed with ether, to remove adherent ethereal liquid containing quinine, heated to boiling and exactly neutralised with dilute sulphuric acid. This decomposes the sodium-cupreine compound, forming sodium and cupreine sulphates. The latter separates in crystals as the liquid cools, and may be collected on a tared filter, dried, and weighed. Only the slightest traces should be obtained, if any.

**TEST FOR CINCHONINE AND AMORPHOUS ALKALOIDS.**—Dissolve 1 gramme of quinine sulphate in 30 C.c. of boiling water, add 1 gramme of sodium potassium tartrate. This causes the separation of quinine and cinchonidine as tartrates; cinchonine and amorphous alkaloids, which are not included in the preceding tests, form fairly soluble tartrates, and remain in solution. The addition of solution of ammonia to the filtrate will then precipitate those free alkaloids which may be present; but according to official requirements little or no precipitate should be obtained.

**Notes.**—The complex formula for quinine sulphate  $[(C_{20}H_{24}N_2O_2)_2H_2SO_4]_2 \cdot 15H_2O$  given in the Pharmacopœia might be expressed more simply as  $(C_{20}H_{24}N_2O_2)_2, H_2SO_4, 7\frac{1}{2}H_2O$ . In both formulæ the loss of water on drying the salt at  $100^\circ$  would be 15.32 per cent. On account of the efflorescent character of quinine sulphate, it must be very seldom that the sulphate containing the full quantity of water of crystallisation is dispensed by the pharmacist. The effloresced salt has the constant composition expressed by the formula  $(C_{20}H_{24}N_2O_2)_2H_2SO_4 \cdot 2H_2O$ , having two molecules of water, but not four molecules, as officially stated. The official statement implies that the Pharmacopœia intends the double, and somewhat irrational, formula  $[C_{20}H_{24}N_2O_2]_2H_2SO_4 \cdot 4H_2O$  to represent the air-dried salt. The Pharmacopœia test for cinchonidine is not a satisfactory one (*vide Pharmaceutical Journal* [4], 6, 412), since it misses nearly one half of the impure crystals of cinchonidine obtainable by a more exhaustive and satisfactory test, and passes as an official quinine sulphate a salt containing nearly 6 per cent. of cinchonidine sulphate. The official test requires alteration chiefly in the directions for fractionally crystallising the sample so as to ensure the presence of as little quinine as possible in the mother liquor which is afterwards treated for cinchonidine. The impurity usually present in quinine sulphate is cinchonidine sulphate, the result of imperfect separation in the course of manufacture. Cinchonine sulphate, a much less costly salt, would only be present as the result of wilful adulteration, because it may be so easily separated from quinine sulphate. Quinidine and cupreine are seldom if ever met with as impurities in quinine sulphate; quinidine because it occurs in very small proportions in the barks used by manufacturers, and cupreine because cuprea bark is seldom, if ever, used as a source of quinine at the present time. The test for cupreine as described in the British Pharmacopœia is very rough. It presupposes a fair admixture of cupreine sulphate, since it is directed to separate it by crystallisation from a strong saline solution. A more exact method would be to either shake the soda liquid containing the cupreine alkaloid with ammonium chloride and ether, or neutralise the soda solution, then shake with ether and ammonia. If cupreine be present even in



traces, the characteristic crystals of that base would separate out from ether in a very short time. It must be remembered that cupreine forms a definite compound with quinine when crystallising from ether, and is only separable by treatment with caustic alkali. This compound of cupreine and quinine, under the name of homoquinine, was erroneously supposed to be a new alkaloid until it was thus decomposed and the cupreine isolated. [*Dose*.—1 to 10 grains.

## Resina.

**Resin**, commonly known as "colophony" or "rosin," is the residue left after the distillation of oil of turpentine from the oleo-resin—crude turpentine—which exudes from various species of *Pinus* (N.O. Coniferæ). After distillation of the oil the melted resin is removed from the stills and run through wire strainers into barrels. The lightest-coloured product is obtained from trees which have been tapped for the first time, and the resin then constitutes about 80 per cent. of the crude turpentine. In subsequent years the proportion of resin in the crude turpentine gradually increases, but the resin from a given tree also becomes darker in successive years.

**Characters and Tests.**—Resin (s.g. 1.070 to 1.085) for medicinal purposes should occur in translucent, compact masses, of a light amber colour, exhibiting a shining glassy surface when broken. It is brittle, easily powdered, possesses a faintly terebinthinate odour and taste, and is soluble in almost all proportions of 90 per cent. alcohol, oil of turpentine, ether, benzol, carbon bisulphide, or hot olive oil. At about 80° C. it softens, but it does not melt completely until the temperature exceeds 100° C. It burns with a dense yellow flame and much smoke, leaving but little ash when the incineration is complete.

**Notes.**—The so-called white resin owes its opacity and dirty-white colour to the presence of water, added while the resin is in a state of fusion. The chief constituent of resin is from 80 to 90 per cent. of three isomeric abietic acids ( $\alpha$ ,  $\beta$ , and  $\gamma$ ). Other substances present are 5 to 6 per cent. of resene, 0.5 per cent. of volatile oil and traces of a bitter principle. Resin may also contain varying quantities (5 to 9 per cent.) of unsaponifiable matter—hydrocarbons formed by decomposition of the abietic acids during distillation. A mixture of gases is given off when the resin is distilled and the so-called "rosin oil" is produced, while soaps are formed and greasy salts of abietic acid produced when resin is boiled with alkaline solutions. Sylvic acid, formerly considered to be a constituent of resin, is now regarded as a decomposition product of abietic acid; the pinic and pimaric acids said to have been found were probably impure products. A mixture of resin and of oil of turpentine is often sold as Venice turpentine, but the substance to which that name properly applies is collected in France and the Southern Tyrol from the larch.

## CLASSIFICATION OF RESINS.

The substances included in the term resins are very widely distributed as constituents of vegetable substances. They appear to be usually degradation products, and to have no further important rôle to play in the metabolic changes

proceeding after their formation. Hence the resins, either alone or in association with gum or volatile oil, or both, are found in glands, which may be lysigenous or schizogenous in origin, from which they frequently exude either naturally or after injury to the plant in which they are formed. Sometimes deposits of resin occur in barks or the heart-wood, and their location in such positions also appears to indicate that they do not serve any further important function in the plant. Resins have been broadly defined as amorphous substances, fusible, insoluble in water, but more or less soluble in alcohol, ether, chloroform, and similar fluids. They usually burn with a smoky flame, and are found by elementary analysis to contain carbon, hydrogen, and oxygen. They have long been regarded as aromatic derivatives, and the property exhibited by some resins, of combining with alkalies to form soluble compounds (resin-soaps) was taken to indicate that such resins were analogous to acids or phenols in constitution, although their acid properties were weak and not manifest to the sense of taste. The naturally occurring resins and the resinous portion of gum-resins and oleo-resins have been found to be mixtures of bodies, often closely allied or homologous. Recent investigations, by Tschirch and others, have cleared up many obscure points in the chemistry of resins and resin-containing substances, and permit of the formulation of a scheme of classification. The naturally occurring resinous substances appear to be mixtures, often highly complex, of various bodies, whose separation in a state of purity is often extremely difficult, and in many cases has not yet been satisfactorily accomplished. Some of the most important resins have, however, been subjected to a thorough examination, and the chemical nature of the separated constituents partly determined. The following appears to be the scheme most generally adopted, the substances occurring as constituents of resinous products being divided into classes based upon their chemical constitution :—

I. RESINOTANNOLS.—These are bodies of a tannoid character, *i.e.*, they give many reactions similar to the tannins ; those, for example with ferric salts, lead acetate and potassium bichromate. They are coloured bodies and appear to have one or more hydroxyl groups, that is, to be alcoholic or phenolic in character, hence the termination *OL* in their name. The individual members of the group are distinguished by prefixing a syllable, indicative of their chief source, to the group name. The more important resinotannols occurring in medicinal substances, and which have been isolated, are :—

SUMARESINOTANNOL.

TOLURESINOTANNOL.

SIARESINOTANNOL.

ALORESINOTANNOL.

PERURESINOTANNOL.

AMMORESINOTANNOL.

GALBARESINOTANNOL.

When oxidised with nitric acid the resinotannols yield picric acid, with more or less facility. This shows that they are aromatic derivatives and also that the hydroxyl group is connected with the aromatic nucleus, *i.e.*, is phenolic in character, since picric acid (tri-nitro-phenol) is so readily formed from them. The presence of the hydroxyl group is also shown by their capacity to form

acetyl and benzoyl derivatives. Beyond these facts little can be said of their constitution, particularly as they are not crystallisable. The formulæ ascribed to them are therefore empirical and based chiefly upon the percentage composition as shown by ultimate analysis.

2. RESINOLS.—These are colourless bodies, not having a tannoid character. They have been obtained in crystalline form and, like the preceding group, contain one or more hydroxyl groups, and have therefore an alcoholic or phenolic character. Since they can be crystallised, the formulæ ascribed to them by elementary analysis can be checked by molecular weight determinations. The following are members of this class:—

BENZORESINOL.

GURJURESINOL.

STORESINOL.

GUAIAACRESINOL.

3. RESINOLIC ACIDS.—These bodies are closely related to the resinols. Their name is intended to recall the fact that they are oxy-acids. One of the chief points of difference between them and the resinols is that they are extracted from ether by agitation with soda-solution, the behaviour of the resinols being the reverse of this. The distinction is due to the acid character of the resinolic acids, since on this account they readily form salts with strong bases. A number of bodies are, however, known, which cannot be referred with any certainty to either of the two groups, but appear to form a connecting link. The resinolic acids can be obtained in crystalline form. The following are members of this class:—

ABIETIC ACID.

PARACOPAIVIC ACID.

COPAIVIC ACID.

PIMARIC ACID.

GUAIACONIC ACID.

4. RESENES.—Under this term are included a number of bodies of unknown constitution. They do not give the reactions of alcohols, phenols, or acids, and they do not appear to be anhydrides, aldehydes, ketones, or esters. They have not been crystallised and are characterised by their great resistance to the action of reagents, and their insolubility in alkalis. Those properties, however, render the resenes very valuable constituents of resinous bodies which are employed in the manufacture of varnishes, since they are not readily affected by exposure to climatic influences. This group therefore includes, in the present state of knowledge, those resin-constituents which cannot be referred to either of the preceding groups. The following resenes may be mentioned as typical of this group:—

DRACORESENE.

COPALRESENE.

OLIBANORESENE.

ALBAN } from

DAMMARESENE.

FLUAVIL } gutta-percha.

The resins, and the resinous constituents of gum-resins and oleo-resins, obtained by natural exudation or by artificial means, appear to be composed of resinols, resinotannols, resinolic acids, and resenes, partly free and partly combined with each other or with various aromatic acids, etc., forming esters, ethers, anhydrides, etc. In the natural substances as they are found in commerce these resinous compounds are usually associated with traces of colouring and other unidentified material which modify their appearance, while



the different proportions in which the various constituents and their compounds occur give rise to the well-known variations in the quality of different samples. Another factor which causes considerable variation in the quality of commercial samples is the exposure to atmospheric and other influences during the period of collection and storage. The following classification of the chief commercial resinous bodies has been proposed by Tschirch, based upon the nature and constitution of their leading constituents:—

(A) TANNOL RESINS.—This group comprises resins which contain chiefly resinotannols in the form of esters. It is divided into two sub-groups according to the nature of the acid or acids with which the resinotannols are combined.

(1) Benzoic or Balsamic Resins.—These contain resinotannol esters of benzoic, cinnamic, or other allied aromatic acids, and are therefore practically identical with what have been termed “balsams.” Some free acid is also usually present. Examples: Benzoin, balsam of Peru, balsam of Tolu.

(2) Umbelliferone Resins.—These include chiefly the gum-resins derived from umbelliferous plants, most of which contain umbelliferone, free and combined as esters with resinotannols. In some of them, however, the umbelliferone is replaced by salicylic or ferulic acid. Examples: Ammoniacum, galbanum, asafetida.

(B) RESENE RESINS.—The resins of this group are distinguished by the large proportion of resenes which they contain. They all appear to be associated with bitter principles.

(1) Burseraceæ Resins.—Resins derived from plants of the natural order Burseraceæ. Examples: Myrrh, elemi, mastic.

(2) Dipterocarpaceæ Resins.—These are derived from plants of the natural order Dipterocarpaceæ, and include dammar and gurjun balsam.

(C) RESINOLIC ACID RESINS.—These are distinguished by containing a large proportion of resinolic acids.

(1) Coniferæ Resins, including substances derived from plants of that natural order. Examples: Sandarac, colophony, amber.

(2) Cæsalpineæ Resins, derived from plants of the sub-order Cæsalpineæ, natural order Leguminosæ. Examples: Zanzibar copal, copaiba.

(D) RESINOL RESINS.—These should contain chiefly resinols, and no resenes or resinolic acids. Example: Guaiacum.

(E) GLUCORESINS.—These include resins of a glucosidal nature. Examples: Jalap and scammony resins.

## Rhei Radix.

**Rhubarb Root** is obtained from *Rheum officinale*, Baillon, *R. palmatum*, Linné, var. *tanguticum*, Maximowicz (N.O. Polygonaceæ), and probably other species growing in North-Western China and Eastern Thibet, where the drug is collected. The plants produce massive, erect, sympodial rhizomes, from which a few stout roots proceed, and the drug, though called rhubarb root, consists chiefly of the erect rhizomes, collected in the autumn from wild plants. After collection the roots and rhizomes are cut into pieces, which are trimmed

and peeled so as to remove more or less of the cortex, and perforated in order that they may be strung on cords while being dried in the sun or by artificial heat. The pieces of rhizome are previously sliced longitudinally if of large size, and portions of the dark corky layer sometimes remain on the pieces. Although the drug is collected in China and Thibet, and exported chiefly from Shanghai, or *viâ* Northern China and Siberia to St. Petersburg, it is known as Turkey or East Indian rhubarb, because it was formerly conveyed by caravan through Persia to the Syrian ports for exportation, or sent from China to Calcutta, whence it was shipped to Europe. There are two chief varieties of rhubarb in commerce—Shensi and Canton; high-dried rhubarb may be of either variety.

**Characters.**—Rhubarb root and rhizome occur in more or less hard, heavy, and compact pieces known in commerce as “rounds” and “flats” respectively. Round rhubarb consists of cylindrical, barrel-shaped, or conical pieces, derived from roots and smaller rhizomes which have not been subdivided, while flat rhubarb consists of plano-convex or irregularly shaped pieces which have been obtained by cutting larger rhizomes longitudinally. The pieces vary considerably in size, but on an average are from 7.5 to 10 Cm. in length, and from 4 to 5 Cm. in thickness. They frequently contain holes, in which may be found fragments of the cord used to suspend the pieces while drying. The surface is rounded or somewhat angular, usually smooth, and frequently covered with a bright yellowish-brown powder, produced by the pieces rubbing against each other, or added to them to improve their appearance. When the powder is removed, the surface is seen to be marked longitudinally with interrupted reddish-brown or dark rusty-brown lines (medullary rays) intermixed with a yellowish-brown, greyish, or whitish substance (bast parenchyma), a delicate light-coloured rhomboidal network being thus formed on the surface, while small scattered star-like marks (fibro-vascular bundles) are also frequently present. The drug breaks with an uneven fracture and the fractured surface presents a marbled appearance, while in some cases, though such are extremely rare, the fractured surface presents what is officially described as a rhomboidal network of reddish lines. A transverse section exhibits no well-marked pith, but a more or less radiating mixture of medullary rays containing reddish-brown colouring matter, and whitish or iron-grey parenchyma containing starch and calcium oxalate. Sometimes a more or less continuous ring of star-like spots (fibro-vascular bundles) can be seen near the periphery of a transverse section of the rhizome, but such spots are not invariably present. The characteristic, somewhat aromatic, odour of rhubarb has been attributed to the presence of a volatile oil. The bitter and feebly astringent taste is due to the presence of a bitter principle and tannin respectively, while the gritty feeling between the teeth, produced when the root is chewed, is caused by the large number of cluster-crystals of calcium oxalate present.

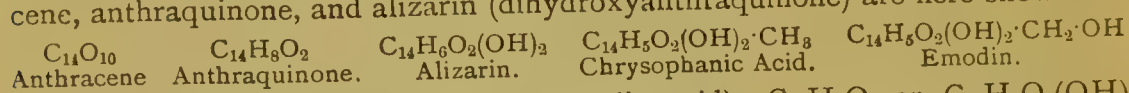
**Notes.**—Chinese or “East Indian” rhubarb is distinguished by the network of whitish lines on the surface, the firm hard texture of the drug, and its freedom from external wrinkles. It is important to note, as already explained, that the drug consists of both root and rhizome, the smaller rounded pieces



being obtained from roots or small rhizomes, while the larger flattened pieces consist of longitudinal slices of rhizomes which occasionally merge into root, so that one and the same piece of the drug may present the characters of both root and rhizome. The pieces bear evidence of having been carefully dressed with a knife, file or scraper, after drying, and the kiln-dried (high-dried) drug is distinguished from sun-dried rhubarb by the shrunken ends of the pieces in the former case. Shensi rhubarb, the most esteemed variety, may be either sun-dried or kiln-dried, the latter being darker externally and frequently somewhat burnt in appearance inside; Canton rhubarb is less dense than the Shensi variety. English rhubarb, from *Rheum officinale*, possesses similar properties, but is less active; it is usually more spongy than Chinese rhubarb, also softer and wrinkled on the outer surface, while it has not a network of white lines on the outer surface, the dark-red and white lines usually running parallel to each other. The roots of *R. officinale* are much narrower than the rhizomes, and their transverse sections exhibit a distinctly radiate structure. Another variety of English rhubarb—from *R. rhaponticum*, or a hybrid between that species and *R. undulatum*—is usually much shrunken, and marked on the outer surface with parallel longitudinal white lines instead of a network. The roots of this variety are much smaller than the rhizomes, and, like those of *R. officinale*, exhibit a conspicuously radiate structure in transverse sections. Chinese rhubarb contains both astringent (tannoid) and purgative (laxative) glucosidal constituents, the latter being probably derived from the tannoids which exist in the same cells of the medullary rays, since similar bodies have been produced by the condensation of two molecules of gallic acid, or one each of gallic and cinnamic acids. The tannoid constituents of the drug are glucogallin,  $C_{13}H_{16}O_{10}$ , catechin,  $C_{15}H_{14}O_6 \cdot 4H_2O$ , tetrarin,  $C_{32}H_{32}O_{12}$ , and free gallic acid; on hydrolysis glucogallin yields gallic acid and dextrose, while tetrarin yields gallic and cinnamic acids, dextrose, and an aldehyde named rheosmin,  $C_{10}H_{12}O_2$ . The purgative constituents of rhubarb are chrysophanein,  $C_{21}H_{20}O_9$ , rheochrysin,  $C_{22}H_{22}O_{10}$ , and rheopurgarin—a crystalline mixture of chrysophanein, rheochrysin, and two glucosides which yield emodin (rheum-emodin) and rhein respectively on hydrolysis. Chrysophanein is a yellow, crystalline glucoside, which yields chrysophanic acid,  $C_{15}H_{10}O_4$ , and glucose on hydrolysis; rheochrysin resembles chrysophanein, but has a lower melting point, and yields on hydrolysis a yellow, crystalline body named rheochrysidin (rhababerone or iso-emodin),  $C_{16}H_{12}O_5$ . Other constituents of Chinese rhubarb are an active oxydase, cholesterol, fat, pectin, dextro-rotatory sugar, starch, and calcium oxalate in large cluster-crystals. The proportion of calcium oxalate present in the drug varies considerably, less being found in English than in Chinese rhubarb, though the former contains more tannoid bodies and starch; the best Shensi rhubarb may contain as much as 25 per cent. of calcium oxalate, but Canton rhubarb contains only 5 to 10 per cent. reckoned as ash. Chrysophanic acid or dihydroxy-methyl-anthraquinone,  $C_{15}H_{10}O_4$  or  $C_{14}H_9O_3(OH)_2 \cdot CH_3$ , is a derivative of anthracene,  $C_{14}H_{10}$ , and closely allied to alizarin,  $C_{14}H_8O_4$ , bearing to methyl-anthracene,  $C_{14}H_9(CH_3)$ , the same relation that alizarin bears to anthracene. It forms golden-yellow needles or plates (m.p.  $186^\circ$ - $188^\circ$  C.),



which are soluble in ether, alcohol, benzene, or alkalies, the alkaline solutions having a fine dark red colour. Emodin or trihydroxy-methyl-anthraquinone— $C_{15}H_{10}O_5$  or  $C_{14}H_5O_2(OH)_2 \cdot CH_3 \cdot OH$ —crystallises in orange-coloured prisms; its relation to chrysophanic acid and the relations of the two bodies to anthracene, anthraquinone, and alizarin (dihydroxyanthraquinone) are here shown—



Rhein (dihydroxy-anthraquinone-carboxylic acid)— $C_{15}H_8O_6$  or  $C_{14}H_5O_2(OH)_2 \cdot CO_2H$ —can be formed from emodin by oxidation with chromic acid. It occurs in minute yellowish-brown scales, which are insoluble in water, ether, or benzene, and only sparingly soluble in alcohol, but form deep purple-red solutions with alkalies and alkaline carbonates.

[Dose.—3 to 10 grains (repeated); 15 to 30 grains (single).]

## Rhæados Petala.

**Red-Poppy Petals** are obtained from the field or corn poppy, *Papaver Rhæas*, Linné (N.O. Papaveraceæ), which is very common in Britain and throughout Europe generally, growing in abundance in cornfields and waste places. The plant bears conspicuous, long-stalked flowers, from which, as they open, the two sepals fall off. There are four delicate, bright scarlet petals which are broader than long, so that their edges overlap in the expanded flower; in the bud they are irregularly crumpled, but they appear smooth and lustrous, and are unctuous to the touch when unfolded. They fall off very quickly, shrink up in drying, and assume a dingy brownish-violet tint. They must, therefore, be preserved with sugar or used while fresh, since they are used solely for colouring purposes.

**Characters.**—Red-poppy petals, when fresh, are of a bright scarlet colour throughout. They are broadly or transversely elliptical in outline, about 5 Cm. broad, with a smooth lustrous surface and an entire margin. They have a slightly bitter taste and a characteristic, somewhat unpleasant, narcotic odour.

**Notes.**—The colouring matter of fresh red-poppy petals is said to consist of rhæadic and papaveric acids; it dissolves readily in water or alcohol, but not in ether. However carefully the petals may be dried, the colouring matter darkens, changing from bright scarlet to dingy violet. Lead acetate also precipitates it from aqueous infusions of the fresh petals as a dingy violet compound, and ferric salts or alkalies change the infusion to blackish-brown. The volatile odorous principle, which is destroyed or driven off on drying the petals, is probably identical with that present in the unripe capsules of *Papaver somniferum* and also found in opium. The presence of morphine in the dried petals has been alleged, but the alkaloid found was probably the crystalline, non-poisonous alkaloid rhæadine,  $C_{21}H_{21}NO_6$ , which is found in all parts of the plant; an intense red colouring matter is liberated when rhæadine is treated with hydrochloric or sulphuric acid, while the isomeric base rhæagenine remains. The presence of meconic acid has not been detected in the petals of *Papaver Rhæas*. The petals of *P. dubium* are said to contain a toxic alkaloid resembling thebaine.

## Rosæ Gallicæ Petala.

**Red-Rose Petals** are obtained from cultivated plants of the Provence rose *Rosa gallica*, Linné (N.O. Rosaceæ), which is probably a native of Southern Europe, but now universally cultivated as a garden plant. The flowers are very large, with obcordate widely-spreading petals of a rich crimson colour, with numerous yellow anthers on thread-like filaments and many hairy styles bearing papillary stigmas. The petals are used both in the fresh and dried state. They must be collected before they have expanded, being removed from the flower-bud as a whole, and the pale-coloured claws removed from the darker-coloured mass. If the confection is to be prepared, the fresh petals are beaten with refined sugar in a stone mortar. For other purposes, however, the masses of petals are carefully and rapidly dried by the heat of a stove, after which they are gently sifted to remove the stamens. The petals are slightly astringent, but are also used because of the colouring matter they contain.

**Characters.**—Red-rose petals usually occur in small conical masses, but may be separate, and are then more or less crumbled. They feel velvety to the touch and are of a deep purplish-red colour generally, though they are brownish-yellow near the base, where the claws have been cut off. The fragrant odour, due to the presence of volatile oil, is more marked in the dried petals. The somewhat bitter, feebly acid, and astringent taste is due to quercitrin and quercitannic acid.

**Notes.**—Artificially-coloured rose-petals have a uniformly dark reddish colour. The red colouring matter of red rose petals is of an acid nature and is turned green by alkalis. The volatile oil to which the odour of the petals is due is present in very small quantity. Gallic and quercitannic acids are also stated to be present in traces, together with an uncrystallisable sugar, fixed oil, salts, and a yellow, crystalline substance,  $C_{16}H_{12}O_6$ , which differs from quercitrin by giving an orange-red instead of a yellow precipitate with lead acetate, and by not yielding quercetin on hydrolysis.

## Saccharum Lactis.

**Milk Sugar or Lactose**,  $C_{12}H_{22}O_{11}, H_2O$ , is a peculiar crystalline sugar, obtained from the whey of milk as a bye-product in the manufacture of cheese. It is present in cows' milk to the extent of about 5 per cent. The whey is separated by coagulating or "curdling" the milk by the addition of a little diluted sulphuric acid, acetic acid, essence of rennet, etc. The curds or clots of casein enclosing the butter fat are then removed, and the whey, which contains the milk sugar and inorganic salts, is evaporated to about one-fifteenth of its original bulk, a brown, viscid, sweetly saline mass resulting. That is set aside for twenty-four to forty-eight hours, and the sugar crystallises out as a bright yellow, granular mass known as "sugar-sand," which is subsequently decolorised by animal charcoal and purified by recrystallisation, the crystals being deposited upon cords suspended in the solution.

**Characters and Tests.**—Milk sugar usually occurs in four-sided prismatic crystals, or in hard, cylindrical, crystalline, greyish-white masses, with a cord around which the crystals have been deposited in the axis of each mass. The sugar should be free from odour, and possess only a faintly sweet taste. It is soluble in 6 or 7 parts of cold water, and in about one part of boiling water, but is almost insoluble in 90 per cent. alcohol. When incinerated with free access of air, the sugar should not leave more than 0.25 per cent. of ash, the presence of magnesium and calcium salts as impurities being thus guarded against. Any lactic acid present should be entirely neutralised on adding 3 drops of volumetric solution of sodium hydroxide to 1 gramme of milk sugar dissolved in 10 C.c. of distilled water.

**Notes.**—The occasional presence of magnesium or calcium salts in commercial milk sugar appears to be due to the addition of magnesia or lime to the whey during the process of crystallisation, in order to neutralise the acid used to curdle the milk. The presence of those salts is objectionable, because they induce or assist coagulation of milk to which the sugar may be added in preparing food for infants. More than traces of lactic acid must also be avoided for the same reason. Milk sugar possesses nutrient properties, and forms a dry and gritty powder which does not absorb moisture or become lumpy, like powdered cane sugar; it thus forms an admirable material for the dilution of potent drugs, and for that reason is used in the preparation of several extracts. It should be noted that lactose reduces Fehling's solution on boiling, but sucrose or cane sugar does not. Milk sugar is isomeric with cane sugar, and can be hydrolysed by treatment with diluted sulphuric acid, galactose,  $C_6H_{12}O_6$ , and dextrose,  $C_6H_{12}O_6$ , resulting.

## Saccharum Purificatum.

**Refined Sugar, Sucrose, or Saccharose,**  $C_{12}H_{22}O_{11}$ , is officially directed to be obtained from the juice of the sugar-cane, *Saccharum officinarum*, Linné (N.O. Gramineæ), but it is also largely obtained from the sugar beet, *Beta vulgaris*, Linné (N.O. Chenopodiaceæ), the Chinese sugar-cane, *Sorghum saccharatum* (N.O. Gramineæ), and other plants. The sugar-cane is an herbaceous plant, which is extensively cultivated in Africa, the East and West Indies, Brazil, and some of the Southern United States of America. The plant possesses a jointed, succulent root, from which arise several shining, jointed, solid stems or canes, which contain a white, juicy pith, in the parenchymatous cells of which the sugar exists in aqueous solution. The canes are cut down close to the ground when ripe, and, after being topped and stripped of the leaves, are crushed in a mill between iron rollers, or they may be cut in thin transverse slices and the juice extracted by diffusion with warm water. The juice constitutes about 90 per cent. of the cane, and is said to contain about 17 per cent. of crystallisable sugar, though not more than 11 per cent. is extracted in practice. The fresh juice is immediately mixed with milk of lime, which causes the formation of a coagulum containing earthy phosphates, a peculiar albuminous principle, and

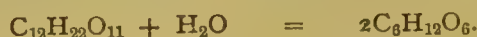


mechanical impurities; the lime also neutralises the acids naturally present, and so prevents conversion of the sucrose into uncrystallisable invert sugar. The juice is next heated in a boiler to  $60^{\circ}$  C., so causing the coagulum to rise to the top as a thick scum, after which the clear liquid is drawn off, concentrated by heat until it assumes a granular aspect, and left to crystallise. The yellowish-brown crystals having been separated by the aid of a centrifugal machine from the brown, syrupy mother-liquor, molasses or treacle, which contains uncrystallisable sugar, salts, etc., the raw sugar thus obtained is subsequently refined, or freed from colour and odour, by treatment with animal charcoal and repeated crystallisation.

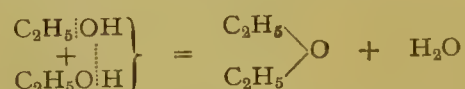
**Characters and Tests.**—Refined sugar occurs in colourless and odourless separate crystals, which dissolve readily and completely in half their weight of cold, distilled water, forming a clear, bright syrup. The absence of glucose or other reducing sugar is proved by not more than a trace of a red or yellowish precipitate being formed on heating the syrup to about  $82^{\circ}$  C. with solution of potassio-cupric tartrate (Fehling's solution), or with solution of copper sulphate and excess of solution of potassium hydroxide. Refined sugar should yield no reaction with the tests for calcium, chlorides, and sulphates. The presence of chlorides or sulphates indicates that the sugar has not been sufficiently purified by recrystallisation; the ash of raw cane sugar contains potassium sulphate and sodium chloride, together with other inorganic salts and the non-volatile residues of the salts of various organic acids. The occasional presence of calcium compounds as impurities in cane sugar is probably due to the use of calcium bisulphite or acid calcium phosphate as a refining agent.

**Notes.**—Any cloudiness in syrups prepared from sucrose is probably due to the presence of insoluble salts, or of ultramarine or Prussian blue which has been used to "face" imperfectly refined sugar by masking its yellow tint. A solution of sugar possesses the property of dissolving a large quantity of calcium hydroxide, forming a compound known as calcium saccharate. Sugar is used in pharmacy for its flavouring and preservative properties. It is important to note that dilute solutions of sugar readily ferment or undergo putrefactive decomposition, while saturated or nearly saturated solutions, such as form the basis of the official syrups, may be preserved indefinitely under proper conditions. This fact is not to be attributed to any specific action, of an antiseptic nature, of sugar upon the lower organisms, but rather to the physical conditions prevailing in strong sugar solutions which possess strong osmotic properties, and consequently seem to disturb the vital functions of the protoplasm of the moulds and bacteria. Such strong solutions are physically unfitted for their growth, although containing a substance which, in a dilute form, provides an efficient nutrient medium. Sugar also retards the oxidation of ferrous salts, and is used with this intention in preparing Ferri Carbonas Saccharata and the official iron syrups. When solutions of cane sugar are boiled with dilute acids, hydrolysis occurs and a product is obtained which was originally named "invert" sugar. This name originated from the fact that the dextro-rotatory action of the sucrose solution was changed to lævo-rotatory in

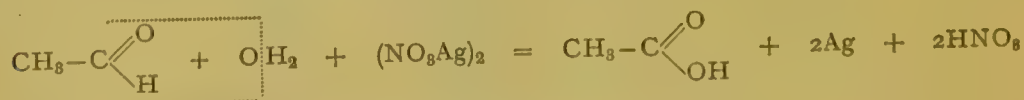
the hydrolysed product, which is now known to consist of equal proportions of dextrose and lævulose. The total rotatory effect of the "inverted" solution is, however, lævo-rotatory, because the specific rotatory power of lævulose is greater than that of dextrose. This inversion with acids is common to the members of the sucrose group of sugars, each variety yielding two molecules of glucose. Two other sugars, maltose and lactose, are very closely related to cane sugar. All three have the empirical formula  $C_{12}H_{22}O_{11}$ , and are hydrolysed by diluted acids to two molecules of sugar of the hexose class, thus—



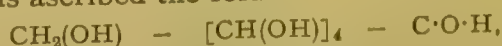
Cane sugar yields dextrose and lævulose, maltose two molecules of dextrose, while milk sugar yields dextrose and galactose, another member of the glucose group. The nature of the hexoses yielded by the three saccharobioses is different in each case, but it is interesting to note that, whereas lactose and maltose, like members of the glucose group, reduce Fehling's solution and react with phenylhydrazine, cane sugar does not. These three sugars are usually regarded as ether anhydrides of the hexoses, *i.e.*, they contain two hexose molecules condensed, with the elimination of a molecule of water, in a manner somewhat similar to the derivation of ether from alcohol—



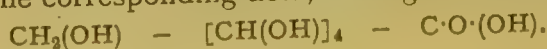
The difference in their behaviour towards Fehling's solution and phenylhydrazine is accounted for on the supposition that this condensation in the case of lactose and maltose only affects one of the  $CO$  groups, so that the resultant condensed product still manifests the properties due to the ketonic or aldehydic group. In the case of cane sugar some rearrangement of the groups must have occurred during condensation by which the aldehydic and ketonic groups of the dextrose and lævulose molecules have become altered, and no longer manifest the properties characteristic of those groupings. It should be noted that the name glucose is applied commercially to the syrupy product obtained by boiling starch with dilute acid. This consists chiefly of dextrose, and is sometimes used as a pill-excipient. In chemistry the name glucose refers to the class of sugars having the formula  $C_6H_{12}O_6$ , and possessing other properties in common. The reducing properties of sugars, such for instance as their action on Fehling's solution, is due to their aldehydic or ketonic nature. Just as ordinary acetic aldehyde which contains the group  $C \cdot O \cdot H$ , easily takes up an atom of oxygen and forms acetic acid, *e.g.*, when it reduces an aqueous solution of silver nitrate—



so dextrose, to which is ascribed the formula—



may be oxidised to the corresponding acid, having the formula—



The actual products obtained by the oxidation of the sugars vary widely, according to the conditions, and it is obvious that there is plenty of room for isomerism, both in the sugars and their decomposition products. The osazones formed by reaction with phenyl-hydrazine are particularly important, since they provide a method for the separation and identification of sugars in complex mixtures, such as urine.

## Salicinum.

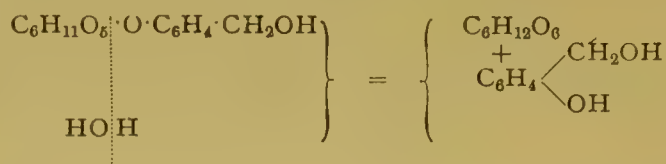
**Salicin** is a crystalline glucoside,  $C_6H_{11}O_5 \cdot O \cdot C_6H_4 \cdot CH_2OH$ , obtained from the bark of the white willow, *Salix alba*, Linné (N.O. Salicineæ), *S. fragilis*, and other species of *Salix*, also from that of the aspen, *Populus tremula*, Linné (N.O. Salicineæ), and other species of *Populus*. It has also been found in many flowers, especially in *Spiræa ulmaria*, Linné, and in castor, the resinous secretion found in the preputial follicles of the beaver, an animal which feeds on willow and poplar bark. To extract it from willow bark, a boiling concentrated decoction is treated with lead oxide, which causes it to become nearly colourless, owing to the removal of gum, tannin, and extractive matter, which would interfere with the crystallisation of the salicin if left in solution. As part of the lead oxide dissolves, apparently in combination with the salicin, sulphuric acid is then added to liberate it, after which barium sulphide is added to complete the separation. The liquid is filtered and evaporated to a syrupy consistence, and the salicin which crystallises out on standing is subsequently purified by recrystallisation. Or the bark may be macerated, and afterwards boiled, in water mixed with lime, and the clear solution obtained evaporated to dryness after concentration and digestion with charcoal; the salicin is then extracted from the residue by treatment with alcohol and purified by repeated crystallisation.

**Characters and Tests.**—Salicin (melting point  $201^\circ$  C.) occurs in colourless, shining, trimetric tabular crystals, which have a very bitter taste. It is soluble in 28 parts of cold water, or 60 parts of 90 per cent. alcohol, but is insoluble in ether. Salicin is coloured red by strong sulphuric acid, a new compound called rutulin being formed; a solution of salicin in strong sulphuric acid is also red, but becomes colourless on adding water, the rutulin being deposited as a dark red powder, insoluble in water or alcohol. On heating a small quantity of salicin with a little potassium bichromate, together with a few drops of strong sulphuric acid and some distilled water, an odour of meadow sweet is given off, owing to the formation of salicylic aldehyde. The same compound is formed when crystals of salicin are cautiously heated in a test-tube until they melt. The absence of mineral impurity is proved by no residue being left when salicin is heated to redness in air.

**Notes.**—The distinctive characters of salicin are its crystalline form, bitter taste, and the evolution of salicylic aldehyde when the crystals are cautiously



heated in a test-tube. On hydrolysis the glucoside splits up into glucose and salicylic alcohol (saligenin,  $C_7H_8O_2$ ), thus :—



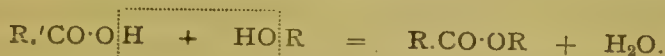
Saligenin is ortho-oxy-benzyl alcohol,  $C_6H_4(OH)CH_2OH$ , and yields a resinous body—saliretin,  $C_{14}H_{14}O_9$ , when heated with dilute acids. Salicylic acid is ortho-oxy-benzoic acid,  $C_6H_4(OH)COOH$ , the relationship between the acid and saligenin being the same as exists between acetic acid,  $CH_3 \cdot COOH$ , and ethyl alcohol,  $CH_3 \cdot CH_2OH$ . Further, just as acetic aldehyde,  $CH_3 \cdot COH$ , is an intermediate oxidation product between ethyl alcohol and acetic acid, so is the volatile oily salicylic or ortho-oxy-benzoic aldehyde,  $C_6H_4(OH)COH$ , the first product of the oxidation of saligenin. When treated with nitric acid salicin yields helicin and helicoidin, and afterwards picric and oxalic acids. Helicin can also be obtained by the reaction between acetochlorhydrose and salicylic aldehyde, and by reducing it with nascent hydrogen salicin can be prepared synthetically. When salicin is heated with dilute sulphuric acid it undergoes hydrolysis, *i.e.*, a molecule of water is taken up with decomposition of the substance into simpler bodies—in this case two, *viz.*, glucose and saligenin. This reaction is typical of all glucosides, to which class of substances salicin belongs, the name glucoside being derived from the fact that when hydrolysed glucose is always formed, the other substances produced simultaneously being, of course, different with each glucoside. Since the glucose may be detected by means of Fehling's solution, this hydrolysis with dilute acids forms a general test for all glucosides. In performing the test the substance to be examined should be heated for three or four minutes in water acidulated with sulphuric or hydrochloric acid. Almost any acid will effect the same change, but not so rapidly as the two mentioned. After boiling, the fluid should be neutralised or made slightly alkaline with potash or soda, a little Fehling's solution added, and boiled again. Presence of glucose will be indicated by reduction of the Fehling's solution (potassio-cupric tartrate) with precipitation of red cuprous oxide,  $Cu_2O$ . It is advisable to neutralise the fluid after boiling, because the reaction between glucose and Fehling's solution, as described, only takes place in alkaline solution, and sufficient acid may be present to neutralise the alkali contained in the reagent added. If only a small quantity of glucoside be taken, sufficient glucose may not have been produced to reduce all the cupric salt in the Fehling's solution. In this case the fluid remains blue, and renders difficult the detection of the correspondingly small quantity of cuprous oxide produced. This may, however, be accomplished by setting the test tube aside, when even a very small quantity of cuprous oxide will form an easily discernible orange-red layer on the bottom of the tube. In this connection it is interesting to compare the remarks made under *Saccharum Purificatum* with regard to the behaviour of cane sugar towards Fehling's solution. The absence of reducing properties in cane sugar and glucosides is probably to be referred

to the same cause, viz., the atomic arrangement in the condensed molecule of cane sugar or glucoside, by which the carbonyl group (to which the reducing properties are due in glucose) is in some way altered. Several formulæ have been proposed, by which it may be shown how the carbonyl group may be supposed to be altered in the cane sugar, and to reappear as ketone and aldehyde in the products of hydrolysis—lævulose and dextrose. The explanation is, however, somewhat hypothetical, and cannot be further pursued here. The formula given for salicin in the Pharmacopœia has been used above to show how that substance splits up on hydrolysis into glucose and salicylic alcohol, the so-called saligenin.

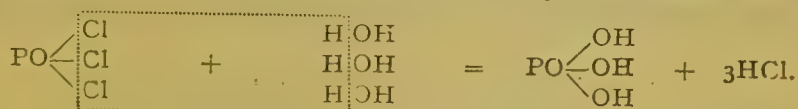
[Dose.—5 to 20 grains.

## Salol.

**Salol**,  $C_6H_4(OH)CO \cdot OC_6H_5$ , is the phenyl ester of salicylic acid or phenyl salicylate, and results from reaction between phenol and salicylic acid. This is in accordance with the usual formation of an ester, water being formed by elimination of hydrogen and hydroxyl, according to the general formula—



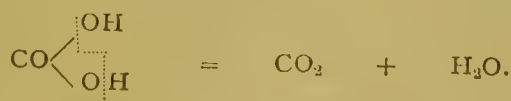
This reaction cannot be realised in the case of phenols, as in the case of aliphatic alcohols, by simply mixing and heating the two constituents—(compare *Æther Aceticus*), for it only occurs at comparatively high temperatures and then is so easily reversed by the water simultaneously formed, that substances which react with the water (and so prevent the reverse change) must be also present. The substances thus employed in the manufacture of salol are phosphoryl chloride,  $POCl_3$  (sometimes known as phosphorus oxychloride) and carbonyl chloride,  $COCl_2$ . The reaction between phosphoryl chloride and water results in the formation of phosphoric and hydrochloric acids.



It is found in practice that a better yield is obtained when the sodium salts of salicylic acid and phenol are employed. In this case sodium phosphate and chloride are produced as by-products, and this prevents a secondary reaction between the phenol and phosphoric acid which results in the production of phenyl esters of phosphoric acid. Carbonyl chloride behaves very similarly to phosphoryl chloride, thus—

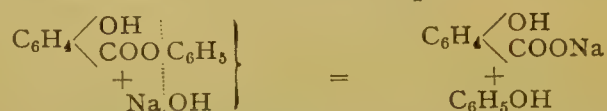


The carbonic acid so formed decomposes immediately into carbonic anhydride and water—

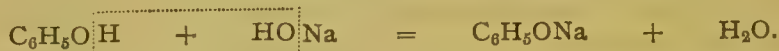


**Characters and Tests.**—Salol (m.p.  $42^\circ$  to  $43^\circ$  C.) occurs in the form of colourless crystals possessing a faint aromatic odour, but almost tasteless. It is

nearly insoluble in water, but soluble in 10 parts of 90 per cent. alcohol, more soluble in hot alcohol, and soluble also in one-third its weight of ether or chloroform, as well as in fixed and volatile oils. When salol is dissolved in alcohol, the solution gives a white precipitate with solution of bromine consisting of an insoluble bromo-substitution derivative formed by replacement of a hydrogen atom in the phenol residue by bromine. The alcoholic solution also gives the violet colour characteristic of salicylates on the addition of a few drops of dilute ferric chloride solution. Salol, like other esters, is saponified by boiling with solutions of caustic alkalies and more quickly by fusion with solid sodium hydroxide as described in the Pharmacopœia.

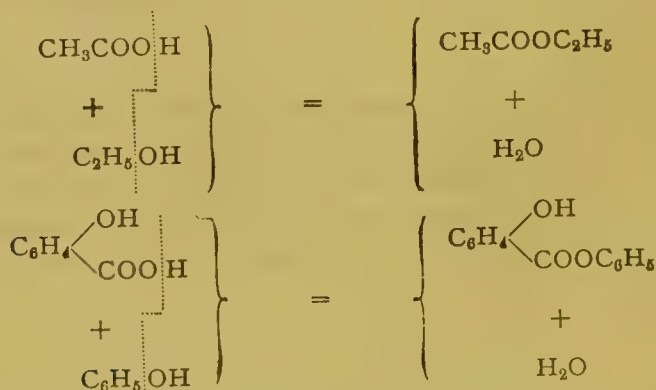


In presence of excess of caustic soda the phenol yields sodium phenate



The fused mass dissolves in water, but on acidulating with hydrochloric acid the sparingly soluble free salicylic acid is precipitated and phenol regenerated. Salol is not decomposed by contact with water, and is practically insoluble; hence if water be shaken with salol, and then filtered, the filtrate should give no colour with ferric chloride unless the salol contains uncombined salicylic acid. Salol should be free from chlorides and sulphates, and its alcoholic solution should be neutral to litmus.

**Notes.**—The esters derived from phenols present certain differences in their formation and reactions when compared to the esters of aliphatic alcohols. For example, ethyl acetate and phenyl salicylate may be regarded as derived in an analogous manner, viz., by the condensation of a molecule of alcohol or phenol and acid with elimination of a molecule of water as shown below—



The practical realisation of these two equations requires, however, very different conditions, owing chiefly to certain differences between the behaviour of the aliphatic alcohols and the aromatic alcohols or phenols. Those differences are chiefly due to the fact that the characteristic hydroxyl group is in one case connected with an aliphatic or open chain radical, and in the other with an aromatic or closed chain nucleus, which is comparatively rich in carbon and poor in hydrogen. This accumulation of carbon atoms causes the phenols



to behave somewhat like acids, *e.g.*, ordinary phenol reacts with potash and soda solutions to form potassium and sodium phenates,  $C_6H_5OK$  and  $C_6H_5ONa$ , because the phenyl radical  $C_6H_5$  is negative and influences the hydroxyl group, so that its hydrogen may be easily exchanged for the more strongly electro-positive metals potassium and sodium. For the production of ethyl acetate, it is only necessary to distil the alcohol and acetic acid in presence of a dehydrating agent like sulphuric acid. For the reason given above, however, the phenols do not so readily exchange the hydrogen of their hydroxyl for acid radicals, and hence this method does not yield good practical results in the case of salol. Some analogy may, however, be found between the behaviour of phenols and tertiary alcohols of the aliphatic series. The tertiary alcohols contain the group  $\equiv C \cdot OH$ , *i.e.*, the hydroxyl is linked to a carbon atom, which is connected by its three remaining valencies with carbon. The phenols also contain their hydroxyl group linked to a carbon atom which is connected with two, or perhaps three other carbon atoms. As a matter of fact, it is found that the formation of esters of tertiary alcohols by the direct action of acids only proceeds to a very limited extent. In the case of esters of phenol the reaction must be assisted by using a high temperature in presence of some agent like phosphoryl chloride (phosphorus oxychloride)  $POCl_3$ , which reacts energetically with the water produced, and so prevents saponification of the ester. The medicinal use of salol is based upon the combination of two powerfully antiseptic and caustic substances—salicylic acid and phenol—into a neutral, almost tasteless substance. Owing to its stability in the acid gastric juice and to its insolubility, salol remains unabsorbed until it reaches the intestine, the secretion of which is alkaline and capable of hydrolysing it into its soluble and active constituents. Hence it is employed as an antiseptic in diseases associated with putrefactive or fermentative changes in the intestine.

[Dose.—5 to 15 grains.

## Sambuci Flores.

**Elder Flowers** are obtained from *Sambucus nigra*, Linné (N.O. Caprifoliaceæ), a small tree which is indigenous to England and distributed throughout the whole of Central and Northern Europe. The small whitish flowers are disposed in umbellate cymes, and the entire inflorescence is collected and sometimes dried entire, but for use in pharmacy the flowers are usually allowed to remain in heaps for a few hours, during which time they become slightly heated, and the corollas then separate from the stalks. Having been removed from the stalks by sifting, the corollas are dried, or "pickled," with common salt, the somewhat disagreeable odour of the fresh flowers being thus gradually changed to a pleasing fragrance.

**Characters.**—Elder flowers are small, and have a slightly bitter taste, with a sweet, but not altogether agreeable, odour when fresh. Dried flowers are yellowish in colour, and have a faint but more pleasant odour. Each flower consists of a three-celled, three-seeded, inferior ovary, bearing five small green calyx teeth, and a creamy-white rotate, deeply five-lobed, monopetalous corolla, with five stamens bearing yellow anthers inserted in the very short tube.

Usually, the corollas and stamens alone are used, those parts separating from the rest of the flowers when left in heaps and allowed to heat slightly as already described.

**Notes.**—The flowers of the dwarf elder, *S. Ebulus*, are distinguished from those of *S. nigra* by having dark red anthers, etc. The flowers of *Achillea Millefolium* and other composites, which have been used as adulterants of elder flowers, differ still more markedly in appearance, and their presence is readily detected. When distilled with water elder flowers yield some ammonia, and a small proportion of volatile oil (specific gravity 0.827), which is solid at ordinary temperatures, and appears to consist of a paraffin and a terpene,  $C_{10}H_{16}$ . By saturating the aqueous distillate with salt, shaking out with ether, and allowing the ether to evaporate spontaneously, as much as 0.32 per cent. of the oil has been obtained. Without the use of ether the fresh flowers have yielded 0.037 per cent. of volatile oil, and the dried flowers 0.0027 per cent. only.

## Santoninum.

**Santonin**,  $C_{15}H_{18}O_8$ , is a crystalline principle obtained from *santonica* or "worm-seed"—the dried unexpanded capitula or flower-heads of *Artemisia maritima*, var. *Stechmanniana*, Besser (N.O. Compositæ), a small perennial plant, which is widely distributed throughout Europe and Asia, and the typical form of which may be found in the salt marshes of the British Islands. The plant bears numerous small flower-heads, about 2 to 4 Mm. long, each consisting of three to six tubular florets and twelve to eighteen involucre scales. When fresh they are of a greenish-yellow colour, but they turn brown when dried and kept awhile, exhaling an agreeable aromatic odour when crushed, and possessing a bitter, aromatic, camphoraceous taste. They are elongate-ovoid in shape and somewhat angular, with a shining surface, which is glabrous or only slightly hairy. The imbricated bracts constituting the involucre are ovate or lanceolate in shape, with a distinct keel, on each side of which shining oil-glands can be seen when the bracts are carefully examined with a powerful lens. The unexpanded florets are completely enclosed by the upper bracts of the involucre, but if a flower-head be well soaked in water the bracts can be removed, and the florets then become visible. The plant varies greatly, but the different forms appear to be merely varieties of the same species. The official variety, which produces "Levant worm-seed," grows freely in the deserts or steppes of the northern portion of Turkestan, and santonin is prepared in large quantities at Chimkent (Tschimkent). The flower-heads are understood to contain it in largest proportion (2 to 3.6 per cent.) in July and August, before they have expanded, and it disappears rapidly after flowering. The capitula are, therefore, collected during July and August and dried. The drug may be mixed with fragments of leaves and slender flower-stalks in considerable proportion. It contains 2 to 3 per cent. of volatile oil (specific gravity 0.915 to 0.940), which possesses the camphoraceous odour of cineol, its chief constituent, modified by that of a terpene or cymene, and an oxygenated substance which is optically lævo-rotatory. The drug also contains santonin, its active principle, and another



crystalline substance named artemisin (melting point  $200^{\circ}$  C.), which is more readily soluble in water or in dilute alcohol. Santonin possesses anthelmintic properties and is poisonous in over-doses. It is extracted from the flower-heads by treating them with milk of lime, converting the calcium compound of santonin so formed into a soluble sodium salt, and then decomposing that by the action of sulphuric or other acid. On cooling the acid liquid the santonin crystallises out, and may be freed from traces of acid by adding a little ammonia to the water used for washing.

**Characters and Tests.**—Santonin (melting point  $170^{\circ}$  C.) occurs in colourless flat rhombic prisms, which possess a feebly bitter taste, is neutral to litmus paper moistened with alcohol, and turns yellow when exposed to light. It dissolves very sparingly in cold water, more freely (1 in 250) in boiling water, and is still more soluble in ether (1 in 140), cold 90 per cent. alcohol (1 in 40), boiling alcohol (1 in 3), or chloroform (1 in 4). Solutions of caustic alkalis also dissolve santonin, but diluted mineral acids do not. A violet-red or pinkish-red colour, which gradually disappears, is produced when santonin is added to a warm alcoholic solution of potassium hydroxide (10 per cent.). It should be noted, however, that many other substances give a similar reaction, and, as a comparatively large amount of santonin is also required to produce any decisive colour, it has been suggested that a better test is the production of a fine rose-red colour on warming a few crystals of santonin in a test-tube with 2 or 3 C.c. of solution of ethyl nitrite, and then adding a few drops of potassium hydroxide solution. The absence of mineral impurities is proved by the absence of residue when santonin is heated to redness and burned with free access of air.

**Notes.**—From its solutions in caustic alkalis, santonin is completely precipitated by supersaturation with an acid. Though it is described as a neutral principle, santonin appears to be the anhydride of monobasic santoninic acid,  $C_{15}H_{20}O_4$ , soluble salts of which are formed by warming santonin with alkalis, whilst prolonged boiling with baryta water results in the formation of the isomeric santoninic acid, which can be resolved into santonin and water by heating to  $120^{\circ}$  C. Exposure of santonin to light is said to cause it to change into uncrystallisable photosantoninic acid,  $C_{15}H_{22}O_5$ , formic acid, and a red resinous substance; similarly, it is stated that when an alcoholic solution of santonin is exposed to sunlight for several months the ethyl ester of photosantoninic acid is formed. With regard to the colour effects produced by santonin, which frequently disturbs the vision, causing all white or brightly illuminated objects to appear of a yellow or greenish-yellow colour, it is noteworthy that, even in non-poisonous doses, the second pair of cranial nerves is affected by the drug. The altered vision is simply due to functional disturbance of the optic nerve, or of its central or terminal endings, and is often accompanied by dizziness and unconsciousness. The so-called "yellow vision" is most common, yellow being the colour which then predominates in all colours containing yellow and violet. In some cases, however, red and blue are replaced by their complementary colours—green and orange—whilst crimson becomes fawn, scarlet appears the colour of bronze, blue acquires a greenish tinge, and green a violet one. In cases of intense poisoning by santonin



“violet vision” prevails, all objects then appearing to vary from violet to ultramarine, according to their depth of tone. [Dose.—2 to 5 grains.

## Sapo Animalis.

**Curd Soap** is made with sodium hydroxide and a purified animal fat, and, as animal fats (*e.g.*, tallow) consist chiefly of stearin, such soap will consist chiefly of sodium stearate. As sold, in blocks or tablets, it contains usually about 30 per cent. of water.

**Characters and Tests.**—Curd soap is white or light grey in colour, dry to the touch, and nearly inodorous. It becomes horny and pulverisable when stored in a warm, dry situation, and becomes plastic when heated. It is soluble in 90 per cent. alcohol, its solubility being much increased by heat. It is only very slightly soluble in cold water, but dissolves freely on the application of heat, being thereby partly hydrolysed by the water into an acid soap (some of which is deposited on cooling) and free alkali. Even if perfectly neutral sodium stearate or oleate be dissolved in water, an alkaline solution is always obtained, and this alkalinity increases with increasing dilution, owing to the dissociating effect of water, which hydrolyses the neutral soap into an insoluble acid soap and free alkali. Hence alkalinity must be determined in strong alcohol which does not have this dissociating action. The Pharmacopœia does not admit the presence of any free alkaline hydroxide in curd soap, because the alcoholic filtrate from 5 grammes of the dried and powdered soap, exhausted by 90 per cent. alcohol, should not give any colour with phenolphthalein. Usually, however, even in the best made soaps, a trace of free alkali is found as carbonate, but since sodium carbonate is insoluble in strong alcohol, it must be sought for in the residue (if any) on the filter paper through which the alcoholic solution has passed. This is, therefore, washed with water, and the filtrate titrated with sulphuric acid, of which not more than 3 C.c. of N/10 solution should be required. This amount corresponds to rather more than 0.3 per cent. of anhydrous sodium carbonate because—

$$\begin{aligned}
 1000 \text{ C.c. } N/10 \text{ H}_2\text{SO}_4 &= \frac{\text{Na}_2\text{CO}_3}{20} \\
 &= 5.2655 \text{ grammes Na}_2\text{CO}_3 \\
 \therefore 1 \text{ C.c. } &= 0.0052655 \text{ „ Na}_2\text{CO}_3 \\
 \text{and } 3 \text{ C.c. } &= 0.0157965 \text{ „ Na}_2\text{CO}_3
 \end{aligned}$$

and 0.0158 gramme  $\text{Na}_2\text{CO}_3$  in 5 grammes of soap is equivalent to 0.316 per cent. Curd soap should not contain any unsaponified fat, and, therefore, does not impart a greasy stain when rubbed on a piece of white, unglazed (blotting) paper. When incinerated, it leaves an ash consisting of sodium carbonate, and since that is non-deliquescent, the test serves to distinguish soda soaps from soaps made with potassium hydroxide, which naturally leave a deliquescent ash of potassium carbonate. It should lose about 30 per cent. of moisture when dried at  $110^\circ \text{C}$ ., the last portions of water being difficult to remove at temperatures below this.

**Notes.**—The official characters and tests for soaps have been considerably amplified in the present Pharmacopœia. Even now they are very incomplete;

for example, the characters and tests for curd and hard soaps are practically identical, and no test is given to show that one is chiefly sodium stearate and the other sodium oleate. The identification by analysis of the exact kind of oil or fat used in making a given sample of soap is a matter of great difficulty, and in the case of a mixture of oils or fats it becomes almost impossible. In the case of two soaps like the official curd soap and hard soap, the difference may be shown very simply in the following manner, which depends upon the separation and determination of the melting points of their fatty acids. Dissolve 5 grammes of the soap (in shavings) in 100 C.c. of hot water. To the solution contained in a beaker add a little solution of methyl orange and then standard sulphuric acid until a permanent acid reaction is obtained. The mineral acid decomposes the soap, forming sodium sulphate and liberating the fatty acids. These, being insoluble in, and lighter than water, rise to the surface of the hot liquid, and form a clear, oily layer. Now set the beaker aside to cool: the oily layer will solidify and form a circular cake which may be removed and dried on blotting paper. In the case of curd soap, the cake will be hard at ordinary temperatures and melt at about  $45^{\circ}$  to  $50^{\circ}$  C. With a soap made from olive oil, the cake of fatty acids will be soft at ordinary temperatures, and melt at about  $25^{\circ}$  C. The method of testing for free alkali in soap should be carefully noted. The limit of moisture allowed in curd and hard soaps is rather high, for there is no difficulty in obtaining soaps containing about 20 per cent. of water. In determining moisture, the soap should be cut into the thinnest possible shavings; even then many hours' heating will be necessary to remove all the moisture.

## Sapo Durus.

**Hard Soap**, made with sodium hydroxide and olive oil, and consisting therefore chiefly of sodium oleate, with about 30 per cent. of water.

**Characters and Tests.**—Hard soap is greyish-white, dry to the touch, and nearly inodorous. It becomes horny and easily pulverisable, owing to loss of moisture, when stored in a warm and dry situation. It dissolves in cold 90 per cent. alcohol and in 20 parts of cold water, the solubility being increased in both cases by the application of heat. Its aqueous solution has an alkaline reaction owing to the partial hydrolysis of soap by water which is described under "Sapo Animalis." It should comply with the tests for alkaline hydroxide and carbonate as described for "Sapo Animalis," should be free from unsaponified fat, and yield a non-deliquescent ash of sodium carbonate. It should lose about 30 per cent. of moisture when dried at  $110^{\circ}$  C.

**Notes.**—The notes on "Sapo Animalis" are equally applicable in the case of hard soap.

## Sapo Mollis.

**Soft Soap** is made from potassium hydroxide and olive oil, and consists chiefly of potassium oleate with a somewhat larger percentage of water than

that usually found in hard and curd soaps. Soft soap cannot be "salted out" or separated by adding common salt to the saponification product, because the potassium oleate and sodium chloride would react with formation of sodium oleate (hard soap) and potassium chloride. In addition to water soft soaps therefore contain also the glycerin which is simultaneously produced by the action of the alkali upon the oil, while in the case of hard soaps the glycerin remains in the salt solution from which the soap has been salted out.

**Characters and Tests.**—Soft soap is yellowish-white or yellowish-green, almost inodorous, plastic, and unctuous. It is soluble in cold 90 per cent. alcohol, and more readily soluble in hot alcohol, the liquid yielding not more than 3 per cent. of insoluble residue on filtration. This allowance is made because soft soap cannot be "salted out" like hard soap. Hence the impurities found in commercial caustic potash—potassium chloride and sulphate and silica for example—remain in soft soap, while in the case of soda soaps they remain in the aqueous liquor from which the hard soap has been "salted out." Those impurities are for the most part insoluble in strong alcohol—hence the allowance of 3 per cent. insoluble residue. Soft soap should comply with the tests for alkaline hydroxide and carbonate, described under "Sapo Animalis," and should contain no unsaponified oil. It yields a deliquescent ash of potassium carbonate, and this ash should be free from copper showing that copper compounds have not been employed to communicate the conventional green colour to the soap.

**Notes.**—The notes on "Sapo Animalis" are equally applicable in the case of soft soap.

## Sarsæ Radix.

**Sarsaparilla** is the dried root of *Smilax ornata*, Hooker filius (N.O. Smilacæ), a native of Costa Rica. The stout knotty rhizome of the plant throws off horizontally a number of slender cylindrical roots, which creep for a considerable distance beneath the surface of the ground. After collection, the roots are dried and made into bundles for exportation. There are many varieties of sarsaparilla root in commerce, but it is officially stated that the kind to be used is that "imported from Costa Rica and commonly known as Jamaica sarsaparilla."

**Characters.**—Sarsaparilla consists of very long, nearly cylindrical, tough, flexible roots, 5 Mm. thick, which are folded together into bundles and bound loosely with a similar root, each bundle measuring about 46 Cm. long and 12.5 Cm. in diameter, and weighing about 1 kilo. The drug is officially described as greyish-brown or dark reddish-brown in colour, though no greyish-brown sarsaparilla appears to be exported from Costa Rica. The roots are much shrunk and deeply furrowed longitudinally, with numerous branching wiry rootlets. A transverse section usually exhibits a narrow dark reddish-brown cortex or bark surrounding a ring of yellowish-white wood with large radially arranged vessels, which encloses a white starchy pith; the cells of the endodermis appear nearly square in transverse section, and are uniformly



thickened, that character distinguishing the root of sarsaparilla from those of other species of *Smilax*. The drug has no odour, and possesses a slightly bitter or acrid taste, due to the presence of saponins. Ash-yield, about 7 per cent.

**Notes.**—The name “Jamaica sarsaparilla” was originally applied to the drug because it was formerly exported *viâ* Jamaica. The distinctive characters of the drug are the shrunken bark in which no transverse cracks are visible, the presence of numerous wiry rootlets, and the appearance of a transverse section. Indian sarsaparilla, from *Hemidesmus indicus*, is marked with transverse cracks and has a distinctive odour, besides being rigid and tortuous, instead of flexible. There are two kinds of “Jamaica” sarsaparilla in commerce, known as “red” and “grey” respectively, but it is doubtful if much, or any, of the latter comes from Costa Rica. Lima, Honduras, Guayaquil, and Vera Cruz or Mexican sarsaparilla are other commercial varieties obtained from species of *Smilax*, but the last three are of poor quality, and only the first-named bears any close resemblance to Jamaica sarsaparilla. The Lima variety is collected in Panama, and the bundles in which it is imported are rather larger than those of Jamaica sarsaparilla, being about 60 Cm. long and 12.5 to 14 Cm. in diameter; Lima sarsaparilla is also greyish-brown in colour, though rougher and thicker than “grey” Jamaica sarsaparilla, whilst the cells of the endodermis are less uniformly thickened than in the official root. Good sarsaparilla should leave a decidedly acrid impression in the mouth after being chewed for a short time; failing that, it is probably inert, either through age or from having been obtained from other species than *S. ornata*. The active principles of sarsaparilla are parillin,  $C_{26}H_{44}O_{10}$ , sarsa-saponin,  $C_{23}H_{36}O_{10}$ , and smilacin (smila-saponin) or sarsaparill-saponin,  $C_{23}H_{32}O_{10}$ , three homologous glucosidal principles belonging to the saponin class (*vide* Quillaia Cortex). Parillin and sarsa-saponin are crystalline, but smilacin is amorphous. Sarsa-saponin is the most active constituent of the drug, but all three compounds produce salivation, vomiting, and diarrhoea. To prevent confusion, it should be noted that parillin was formerly known as “smilacin.” Other constituents of the root are starch, resin, colouring matter, and a trace of volatile oil, also calcium oxalate and other salts.

## Sassafras Radix.

**Sassafras Root** is obtained from *Sassafras officinale*, T. Nees and Ebermaier (N.O. Laurineæ), a tree of medium size, indigenous to North America. All parts of the plant secrete an aromatic volatile oil in special cells, but the bark of the root is richest in oil, and, medicinally, the most active, though the whole root is official. The root is collected after the occurrence of frost in autumn, then dried and exported in large branching logs, 15 to 30 Cm. in diameter, which often include the lower portion of the stem. The bark of the root is nearly white at first, but becomes coloured on exposure, immediately after collection, owing to the decomposition of the tannin it contains.

**Characters.**—Sassafras root occurs in large branched pieces, which are more or less covered with rough greyish-brown or rusty-brown bark. Internally, the bark is smooth, glistening, and rusty-brown, with an agreeable aromatic

odour, and a peculiar aromatic, somewhat astringent taste, the odour and taste being due to the presence of volatile oil. The wood is soft, light, and easily cut, greyish-yellow or greyish-red in colour, with a similar taste and odour to the bark, though more feeble. A transverse section of the wood exhibits distinct annual rings, traversed by fine dark medullary rays, and containing large vessels. Oil cells are found in the wood, but they are more numerous in the bark.

**Notes.**—The chief constituent of sassafras is a volatile oil (specific gravity 1·070 to 1·080), of which the root contains about 2 per cent., while air-dried root bark yields as much as 6 to 9 per cent. The oil consists chiefly of safrol, together with pinene, phellandrene, and camphor, but it is also stated to contain traces of eugenol, sesquiterpene, and other substances of high boiling point. It is sometimes adulterated with camphor oil, which contains safrol and other substances found in oil of sassafras, and may have a similar specific gravity. Other constituents of sassafras root are tannin and starch; in addition, the bark contains gum, resin, wax, salts, and a peculiar decomposition product of tannic acid named sassafrid, which bears some analogy to cinchona red. The tannin is present in much larger proportion in fresh bark than in that which has been long kept, and its oxidation is the cause of the change of colour which takes place.

## Scammonia Radix.

**Scammony Root** is obtained from *Convolvulus Scammonia*, Linné (N.O. Convolvulaceæ), a twining plant which resembles the common bindweed, *C. arvensis*, and is indigenous to Syria and other places in the Eastern Mediterranean. The plant has a perennial tapering root, covered with a greyish bark and containing a milky juice. The root varies in size, according to its age, and may attain a length of 1 M. or more and a thickness of 20 to 30 Cm.

**Characters and Tests.**—Scammony root occurs in hard, heavy and woody, brownish-grey, or yellowish-grey, tapering or nearly cylindrical pieces, which vary usually from 2·5 to 7·5 Cm. or more in diameter, and are slightly enlarged at the crown, where may be seen the remains of the slender aerial stems. The root is frequently contorted or spirally twisted, and is invested with a thin inconspicuous bark, the rough surface being furrowed longitudinally. Any lateral rootlets present are commonly split into fibrous strands. The root breaks with a coarsely fibrous fracture, strands of wood projecting from the fractured surface, which is seen to be whitish or grey when smoothed. A transverse section exhibits an abnormal and characteristic structure. There is no distinct central wood, but numerous irregularly arranged wood bundles appear as ill-defined circles, in which groups of vessels are surrounded by parenchymatous tissue, containing resin cells which appear as dark points. The whole of the parenchymatous tissue of the root contains starch grains of characteristic shape. The peculiar odour of the drug recalls that of jalap, and is more distinct when the surface is freshly cut; the taste is sweetish at first owing to the presence of sugar, but afterwards slightly acrid, the acidity being due to a glucosidal resin which can be extracted by alcohol.



**Notes.**—The distinctive characters of scammony root are its large size, fibrous fracture, greyish colour, jalap-like odour, and the appearance of a transverse section. Belladonna root is usually much smaller, breaks with a short mealy fracture, and is free from odour, whilst a transverse section exhibits a dark cambium line, separating the greyish bark from the whitish wood, in which are scattered dark groups of vessels and fibres. The chief constituent of scammony root is a glucosidal resin or glucoresin—scammonin—of which it contains from 3 to 13 per cent.; the root also contains sugar and starch.

## Scammoniaë Resina.

**Scammony Resin** is extracted from the dried root of *Convolvulus Scammonia*, Linné (N.O. Convolvulaceæ), by exhausting the drug with alcohol. After recovering the greater part of the alcohol by distillation, the remaining liquid is slowly poured into three times its volume of distilled water, the liquid being constantly stirred meanwhile, and the resin allowed to subside, after which it is washed with distilled water and dried on a water-bath.

**Characters and Tests.**—Scammony resin occurs in brownish, translucent, brittle pieces, which break with a shining fracture and possess a sweet, fragrant odour. It is distinguished from the gum-resin of scammony by not forming an emulsion when triturated with water, and from jalap resin by being almost entirely soluble in ether (specific gravity 0.735). The absence of guaiacum resin is proved by an alcoholic solution giving no blue colour with test-solution of ferric chloride or with solution of hydrogen peroxide.

**Notes.**—The resin of scammony consists almost entirely of scammonin, which is apparently identical with the ether-soluble portion of jalap resin, as well as with the resins of Tampico jalap and male jalap. It has been stated that the solubility of scammony resin in ether is modified by the presence of alcohol and water, resin which is entirely soluble in ether containing 15.5 per cent. of alcohol being much less soluble in absolute ether, while the presence of less than 1 per cent. of water is said to reduce the solubility of the resin by nearly 24 per cent. The quantity of ether employed to dissolve the resin is also alleged to affect the solubility of the latter, a clear saturated solution of scammony resin in ether yielding a precipitate on adding more of the solvent. When purified by the removal of colouring matter, scammonin is a white powder. It yields scammonic and other acids when treated with alkalies, and, scammonic acid, in turn, yields scammonolic acid and sugar on hydrolysis with mineral acids, though scammonin, similarly treated, yields scammonol, the anhydride of scammonolic acid, together with valerianic acid and sugar.

*Dose.*—3 to 8 grains.

## Scammonium.

**Scammony** is a gum-resin obtained by incision from the living root of *Convolvulus Scammonia*, Linné (N.O. Convolvulaceæ), and the best qualities are known in commerce as virgin scammony. The cells containing the liquid gum-resin are arranged in vertical rows in the cortex of the root and in the



parenchyma, surrounding each of the wood bundles or columns mentioned in the description of scammony root. In collecting the gum-resin the upper parts of the roots are exposed, and incisions are made in a slanting direction 5 to 10 Cm. below the crown, in such a way that the contents drain from a series of cells by the breaking of the transverse walls. The exuding milky juice is received in fresh-water mussel shells placed just beneath the incisions, and, towards evening, the shells are usually removed, while the cut surfaces are scraped with a knife, so as to remove any partially dried drops of gum-resin. Only a small quantity is collected from each root, and the product of several plants is therefore mixed into a homogeneous mass in any convenient vessel and allowed to harden. If the gum-resin be left to dry as it exudes, it has a fine golden-brown colour and translucent appearance; but the effect on the mixed product of long standing in a more or less moist condition is that it undergoes a fermentative change, so that the dried drug has usually a darker colour and a porous appearance when broken. The gum-resin is collected in June, and exported chiefly from Smyrna and Aleppo.

**Characters and Tests.**—Scammony is usually imported in flattened cakes about 12 Mm. thick, and 10 or 12 Cm. in diameter, or in irregular fragments of varying sizes. It is brown, dark grey, or nearly black externally, and often covered with a greyish-white powder formed by the pieces rubbing against each other. The cakes are very brittle, and when broken the freshly-exposed surfaces appear glossy, resinous, more or less porous, and of a uniform dark-brown or nearly black colour, though thin fragments are brown and more or less translucent when viewed by transmitted light. The drug is easily reduced to an ash-grey powder, which readily forms a milky emulsion when rubbed with water. The peculiar cheese-like odour of scammony is probably due to a volatile fatty acid developed by fermentation during the process of drying; the taste is slight, but an acrid sensation is left in the throat by the drug. Though scammony naturally contains a little starch, the blue coloration afforded on applying the iodine test should be only slight. At least 70 per cent. of the drug should be soluble in ether (specific gravity 0.735), and not more than 3 per cent. of ash should be left on incineration, a larger proportion indicating adulteration with inorganic matter. The absence of guaiacum resin is indicated by the absence of blue colour when test solution of ferric chloride (5 per cent.) is added to an alcoholic solution of the drug.

**Notes.**—The resin of scammony is distinguished from the gum-resin by possessing a much more agreeable odour, a different colour, and the fact that it does not form an emulsion with water. The gum-resin is frequently adulterated, whilst in the soft state, with the expressed juice of stalks and leaves of the scammony plant, as well as with wheat flour, chalk, ashes, sand, or foreign resins; it is stated that it may also consist wholly or in part of the expressed juice of the root, evaporated to dryness by exposure to the sun or by artificial heat. Adulteration with inorganic matter is readily detected by the amount of ash left on incineration, and foreign starch can be recognised on examining the powdered drug under the microscope. Inferior scammony is usually tough and has a dull fracture, small splinters being opaque. Pure scammony consists of

gum and resin—scammonin—identical with that obtained from the dried root. The resin is entirely soluble in ether, and may constitute from 80 to 90 per cent. of the drug, though it is usually present in smaller proportion. The variation in that respect is so great that the pure resin alone is now used for making the official galenical preparations. [Dose.—5 to 10 grains.

## Scilla.

**Squill** is the bulb of *Urginea Scilla*, Steinheil (N.O. Liliaceæ), a perennial plant, indigenous to countries bordering on the Mediterranean. The bulb is pear-shaped, and may attain the size of a child's head. It consists of fleshy scales attenuated at their outer edges, closely applied over each other, and invested by very thin and dry exterior scales which appear to constitute a membranous coat. There are two varieties of squill—red and white—which are said to be alike in medicinal value, though the white squill collected in Malta is preferred in England, whilst the red squill collected in Algeria is used in France. In the first, the whole bulb is white or yellowish, whereas the red squill has deep reddish-brown outer scales and yellowish-white inner scales, covered with a pinkish epidermis. The dry, membranous outer scales must be removed, and the bulb cut into slices and dried. When fresh, the bulb abounds in a viscid, very acrid juice, which is capable of causing inflammation of the skin; on drying, it loses four-fifths of its weight, and its acidity is largely diminished, with but slight loss of medicinal activity. The drying process is difficult, on account of the abundance and viscosity of the juice; it is necessary, therefore, to cut the bulb into thin transverse slices, which are dried separately by solar or artificial heat. The outer scales are rejected because they are dry and destitute of activity; it is also usual to reject the central scales, as they are very fleshy and mucilaginous, besides being destitute of bitterness.

**Characters.**—Squill usually occurs in narrow, flattish, curved strips or slices of the inner scales of the bulb, from 2.5 to 5 Cm. long, and about 3 Mm. thick. They frequently taper towards both ends, are yellowish-white or somewhat pinkish in colour, and more or less translucent. When quite dry, the strips are brittle and can easily be powdered, but they are tough and flexible when moist. The odour of the drug is very slight, but the taste is disagreeably bitter and acrid, owing to the presence of bitter glucosides.

**Notes.**—The distinctive characters of squill are the shape and colour of the strips in which it is usually seen, and the nauseously bitter taste of the drug. Occasionally the drug is seen in vertical slices, some of which adhere at their base, and the whole bulbs are sometimes imported, but they are difficult to keep, as they preserve their vitality for a long time, and tend to develop aerial shoots if left in a warm place. The bitter taste of the squill appears to be due to three glucosidal substances—scillitoxin (scillain), scillipicrin, and scillin. The first two glucosides are amorphous, and act upon the heart; the third is crystalline, and inactive. Other constituents

of squill are mucilaginous and saccharine matters, including a peculiar mucilage named sinistrin,  $C_6H_{10}O_6$ , which is probably identical with tritacin and irisin; calcium oxalate is also present, in bundles of long acicular crystals which easily penetrate the skin when the bulbs are handled, and cause intense irritation. [Dose.—1 to 3 grains.

## Scoparii Cacumina.

**Broom Tops** are obtained from *Cytisus Scoparius*, Link (N.O. Leguminosæ), a woody shrub indigenous to England and distributed throughout temperate Europe. The dark green stem produces numerous straight, pentangular, flexible branches, on which are borne small, oblong, downy leaves and numerous large golden-yellow, papilionaceous flowers, the latter being succeeded by compressed legumes which are hairy at the sutures. The whole plant has a bitter, nauseous taste and a strong peculiar odour when bruised, but only the tops of the stems and branches are official. Both fresh and dried tops are used, the former for the preparation of the juice and the dried tops for making the infusion. The odour disappears and the leaves easily fall off the branches on drying, the dried tops usually consisting of dark brownish-green stems and branches only, without leaves, flowers or fruits.

**Characters.**—Broom tops consist of the young stems, with long, straight, slender, alternate branches; the branches and the upper part of the stem bear five distinct wings and are glabrous, tough, and flexible. The tops are dark green when fresh and dark brownish-green when dried. The small alternate leaves are downy whilst young, but are usually absent in the case of dried tops; when present, they are sessile and simple above, but stalked and trifoliate below. The bitter, nauseous taste is due to sparteine. The fresh tops have a characteristic odour which is probably largely due to the volatile oil present; it is especially marked when the tops are bruised, but it disappears almost entirely on drying.

**Notes.**—The distinctive characters of broom tops are the winged branches, bitter taste, and peculiar odour when fresh. The chief constituent of the drug is the liquid volatile alkaloid, sparteine,  $C_{15}H_{26}N_2$ , which has a peculiar bitter taste, has an odour of aniline, and forms crystalline salts. Other constituents are a volatile oil, tannin, fat, wax, sugar, and an indifferent substance, named scoparin, which forms yellow crystals and yields phloroglucin and protocatechuic acid when fused with potassium hydroxide. By the action of potassium bichromate and sulphuric acid, sparteine is converted into oxysparteine and that, in turn, yields trioxysparteine when acted upon by hydrogen peroxide, dioxysparteine being similarly formed when hydrogen peroxide is allowed to act directly upon sparteine.

## Senegæ Radix.

**Senega Root** is obtained from *Polygala Senega*, Linné (N.O. Polygalææ), a small plant found in almost all parts of the United States and in the southern parts of British North America. The dried root alone is official, and only



that collected in the Southern and South-Western States of America accords strictly with the official description.

**Characters.**—Senega root occurs in slender, greyish-yellow or brownish-yellow pieces with but few branches, the pieces varying from 5 to 10 Cm. in length, and being enlarged at the top into a knotty crown, to which are attached the remains of numerous slender aerial stems and small shoots, beset with the scars or remains of purplish scaly leaves. The root is frequently curved and contorted, longitudinally wrinkled, and sometimes also transversely wrinkled near the crown, whilst a prominent keel may usually be found on the concave surface of the curves of the root, following a somewhat spiral course. The fracture of the root is short, and a transverse section exhibits a yellowish, horny, translucent cortex or bark, which is free from starch grains, and encloses a whitish wood, which is frequently irregularly developed. Thus, instead of the wood forming a complete circle, one or two wedge-shaped portions may be replaced by parenchymatous tissue, which fills transverse cracks and longitudinal fissures in the wood, as can be seen on soaking a keeled root in water, and stripping off the bark. The keels on the concave sides of curved roots are due to a largely developed bast, and do not arise from any abnormal development of the wood. The distinctive odour of the root, recalling that of wintergreen, is due to volatile oil. The sweetish taste, due to the presence of sugar, is more or less masked by the acidity and irritating sensation caused by the saponins present. Ash-yield, about 4 per cent.

**Notes.**—The distinctive characters of senega root are the prominent keel, the irregular wood as seen in transverse sections, the distinctive odour, and the sweetish, yet acrid taste. Northern senega, collected in the North-Western States of America, from *P. Senega*, var. *latifolia*, is much larger than the official variety, darker in colour, less tortuous, and shows the keel less distinctly, if at all. White, or false senega, collected in the Southern States of America, from *P. alba*, Nuttall, is more slender than the genuine root, has branches which descend without spreading, and has a normal cylindrical wood; it is also lighter in colour than true senega, and keelless. The chief constituents of senega root are two homologous glucosides—senegin and polygalic acid, which resemble, but are not identical with, the saponins—quillaja-sapotoxin and quillajic acid—found in quillaia bark, and can be obtained as a white, inodorous powder, with a pungent, acrid taste. Other constituents of senega root are fixed oil, resin, and a little volatile oil containing methyl salicylate and an ester of valerianic acid; also sugar, pectin, and yellow colouring matter.

## Senna Alexandrina.

**Alexandrian Senna** consists of the dried leaflets of *Cassia acutifolia*, Delile (N.O. Leguminosæ), a small shrub found growing wild in the Middle and Upper Nile territories. The alternate and paripinnate compound leaves are collected chiefly between Suakim and Kassala, by Bedouins, who separate

them from the petioles, after which they are dried, and exported by way of the Red Sea ports or Alexandria. In some parts, however, the senna plants are cut down by the natives, who dry them in the sun and strip off the leaves and pods, which are then packed in bales and sent to Boulak, near Cairo, where they are sorted.

**Characters.**—Alexandrian senna consists of pale greyish-green, thin, brittle, slightly curled leaflets, which usually vary from 20 to 32 Mm. in length. They are mostly lanceolate in shape, though sometimes oval-lanceolate, with an acute apex and entire margin; they are also unequal at the base, and the greatest diameter is frequently below the middle of the leaflet. Both surfaces of the leaflets are frequently finely pubescent, especially near the veins, which are distinct on the under surface. When examined by the aid of a microscope the hairs on the epidermis are seen to be one-celled and thick-walled, a distinction being thus afforded between senna leaflets and argel leaves, the hairs of which are three-celled. The odour of senna is faint and herb-like, and its taste is mucilaginous and somewhat unpleasant, the odour and taste being largely due to constituents of the drug—resin and a trace of volatile oil—which are soluble in strong alcohol, and can be removed without greatly affecting the purgative property of the drug. Ash-yield, 10 to 13 per cent.

**Notes.**—The leaflets of *Cassia abovata*, Colladon, are occasionally found mixed with Alexandrian senna; they are broadly obovate and mucronate, with an abruptly tapering apex and distinctly pinnate venation. East Indian senna leaflets, from *C. angustifolia*, Vahl, are usually longer in proportion to their width, flat, yellowish-green in colour, less conspicuously assymetrical and also less pubescent. Argel leaves, from *Solenostemma Argel*, Hayne, which formerly constituted a common adulterant of Alexandrian senna, are distinguished by their thick, rigid texture and finely wrinkled surface, whilst they are equal at the base, and their veins are not evident; they are also distinctly bitter and have three-celled hairs. Alexandrian senna frequently arrives in this country in a more or less broken condition, owing to the brittle nature of the leaflets and is sometimes mixed with the flat, curved, brown, or greenish-brown pods, and fragments of the leaf-stalks. The drug appears to contain varieties of emodin, iso-emodin, and chrysophanic acid, together with glucosides which yield those bodies on hydrolysis, one of those being glucosennin, which yields emodin and a sugar. The emodin (senna emodin) is a trihydroxy-methyl-anthraquinone which is apparently identical with oloe-emodin, but different from frangula-emodin and rheum-emodin. Senna-isoemodin resembles senna-emodin, but is soluble in petroleum spirit. The name anthra-glucosennin has been given to a mixture of substances obtained by exhausting senna with weak ammonia, precipitating with hydrochloric acid, drying the precipitate, exhausting it with alcohol, and evaporating the alcoholic solution to dryness. Senna-rhamnetin and senna-nigrin are ill-defined bodies left in the drug, after extraction of the emodin, etc., by means of ether and acetone. The substance known as carthartic acid is a mixture, and senna-chrysophanic acid is probably distinct from ordinary chrysophanic acid. Other constituents of senna are mucilage and a sugar named pinite (sennite).

## Senna Indica.

**East Indian or Tinnevelly Senna** consists of the dried leaflets of *Cassia angustifolia*, Vahl (N.O. Leguminosæ), and should be obtained from plants cultivated in Southern India, especially in the district of Tinnevelly. The plant is indigenous to Southern Arabia, but attains an unusual size and produces larger paripinnate leaves under cultivation than when growing wild. After collection the leaflets are dried, pressed into bales, and exported from Tuticorin. They are much more largely used than Alexandrian senna, but either kind may be employed in making the official preparations.

**Characters.**—East Indian senna consists of yellowish-green, thin leaflets, which usually vary from 25 to 50 Cm. in length. In shape they are lanceolate, with an acute apex and entire margin; they are also unequal at the base, and the greatest diameter is usually near the middle of the leaflet. The upper surface is smooth, the lower surface somewhat duller in colour and glabrous, or slightly pubescent. The herb-like odour and slight taste of the drug are very similar to those of Alexandrian senna, and due to the presence of the same constituents—resin and a trace of volatile oil.

**Notes.**—In addition to their more elongate lanceolate shape, as compared with the leaflets of Alexandrian senna, the leaflets of the East Indian plant are also somewhat firmer in texture, and are consequently less broken when they arrive in this country. Tinnevelly senna is usually free from admixture of any kind. Arabian or Mecca senna, collected in Southern Arabia from wild plants of *Cassia angustifolia*, is sometimes imported, but the leaflets are usually mixed with stalks and discoloured, owing to lack of care in collecting and drying. The fruits of *C. angustifolia* closely resemble those of *C. acutifolia*, but they are rather narrower, and the remains of the base of the style are usually more distinct. The constituents of Tinnevelly senna appear to be identical with those of Alexandrian senna.

## Serpentariæ Rhizoma.

**Serpentary Rhizome** is obtained from the Virginian Snakeroot, *Aristolochia Serpentina*, Linné (N.O. Aristolochiaceæ), or from the Texan or Red River Snakeroot, *A. reticulata*, Nuttall, both plants being natives of the United States. The first is a small herbaceous plant which grows to the east of the Mississippi. It has a short rhizome with numerous slender roots. Both rhizome and roots are official, but the drug consists chiefly of the roots; they are collected in the autumn, dried, and sent to Philadelphia in bales containing about 45 kilo., the leaves and stems of the plant being often present as impurities, as well as adhering dirt. The drug at present in commerce, however, is chiefly obtained from *A. reticulata*, which grows in the South-Western States of America; it is somewhat bolder in appearance than Virginian snakeroot, and the roots are less interlaced.

**Characters.**—Serpentary rhizome from *A. Serpentina* is tortuous, slender, about 2.5 Cm. in length and 3 Mm. in diameter. On the upper surface of the



rhizome may be seen the remains of aerial stems, and numerous wiry interlacing roots, often about 7·5 Cm. long, occur on the under surface, forming matted masses. The fresh rhizome and roots are yellowish, but they become dull yellowish-brown with age. The drug has a camphoraceous odour, due to the presence of a volatile oil, and strong aromatic bitter taste, due to the volatile oil and an alkaloid. The rhizome and roots of *A. reticulata* resemble those of *A. Serpentaria* in colour, odour, and taste, but they are longer and thicker. The roots are also less curved in this variety of the drug, they are not wiry or interlacing, and they frequently approximate in thickness to the rhizome from which they spring. Serpentary rhizome and roots are brittle, breaking with a short fracture. A transverse section of the rhizome exhibits an eccentric whitish pith which is much nearer the upper than the under surface, numerous yellow curved wood bundles, and a thin yellowish-brown bark; a similar section of the root shows a slender yellow wood, enclosed by a thick whitish bark.

**Notes.**—The rhizome of Indian pink (*Spigelia marilandica*, Linné) is darker in colour than serpentary, and has an oval or crescent-shaped pith, surrounded by a ring of wood which exhibits no characteristic structure; the rhizome also lacks the characteristic odour and taste of serpentary. Hydrastis rhizome (*Hydrastis canadensis*, Linné) is yellow and differs in structure and odour from serpentary, as also do other rhizomes and roots which have at times been confused with it. Small pieces of valerian root sometimes bear a superficial resemblance to serpentary, but the different odour and taste suffice to distinguish them. The active principles of both kinds of snakeroot are a bitter crystalline alkaloid named aristolochine, and from 1 to 2 per cent. of a volatile oil; other constituents of the drug are tannin, starch, sugar, and resin. The volatile oil of *A. Serpentaria* has a valerian-like odour and consists chiefly of borneol; that of *A. reticulata*, which has an odour recalling those of camphor and valerian, contains borneol, combined with an acid which has not yet been identified, and a terpene which is probably pinene.

## Sevum Præparatum.

**Prepared Suet** consists of the internal fat of the abdomen of the sheep, *Ovis aries*, Linné (Order Ungulata), purified by melting and straining. The fat is contained in the omentum (flare) or fold which covers the intestines of the sheep and is taken chiefly from the region of the kidneys. The omentum is cut into pieces, which are thoroughly crushed so as to break the membranous vesicles in which the fat is enclosed, after which a moderate heat is applied and the melted fat subsequently strained through linen or flannel. Mutton suet is of a firmer consistence and is said to require a higher temperature to melt it than any other animal fat; in order to avoid applying too much heat, the crude suet is sometimes purified by boiling it in water.

**Characters and Tests.**—Prepared suet (specific gravity 0·948 to 0·953) is white, smooth, and almost free from odour; it melts at 44·4° to 48·9° C., and begins to resolidify at about 37·8° C. It is freely soluble in petroleum spirit

(1 in 2), dissolves slowly in benzol, and is slightly soluble (1 in 60) in ether (specific gravity 0.735) or in boiling alcohol (1 in 44), but is insoluble in cold alcohol.

**Notes.**—The high melting point is a very distinctive character of prepared suet. On cooling melted suet, constituents of a high melting point tend to separate in a more or less granular form; it should, therefore, be stirred whilst cooling, so as to obtain it in an homogeneous condition. It contains approximately 70 to 80 per cent. of stearin and palmitin, with 20 to 30 per cent. of olein. Benzoated suet is prepared in the same way as benzoated lard, except that suet replaces lard.

## Sinapis.

**Mustard or Mustard Flour** consists of the dried ripe seeds of *Brassica sinapioides*, Roth. (N.O. Cruciferae), and *B. alba*, Boissier, powdered and mixed. The reason usually given for mixing the black and white seeds is that black mustard seeds frequently contain insufficient myrosin to decompose the whole of the sinigrin present, but white mustard seeds contain an excess of the ferment, so that by mixing the two a powder is obtained which is capable of developing a maximum of pungency when moistened with water. Inasmuch, however, as the activity of ferments is not limited in the manner suggested, it is probably more in accordance with fact to say that the black seeds contain insufficient myrosin to effect decomposition of all the sinigrin present in a limited time. The additional myrosin which exists in the white seeds may, therefore, have the effect of helping to produce the maximum amount of volatile oil more rapidly than would otherwise be possible. But the main object in using both black and white mustard seeds for preparing mustard flour is probably the production of a commercial article with a better flavour than could be obtained otherwise.

**Characters and Tests.**—Mustard is a yellowish or greenish-yellow powder, which is inodorous or possesses only an oily smell when dry, but gives off a characteristic pungent odour when moist, owing to the formation of allyl isothiocyanate, the bitter, pungent taste of the powder being due to that compound and undecomposed sinigrin. A cooled and filtered decoction of mustard should not be coloured brown on adding a solution of boric acid, or deep blue on adding solution of iodine, the absence of turmeric and starch respectively being thus indicated. The absence of starch may also be proved by microscopical examination.

**Notes.**—Though starch is present in unripe mustard seeds—black or white—it is not found in the ripe seeds. It is, nevertheless, a common constituent of commercial mustard flour, being sometimes derived from starch-bearing seeds which are accidentally mixed with the mustard seed, or, in other instances, added as a diluent. The presence of starch is best detected by the aid of the microscope, as it is stated that the iodine test for the presence of starch may be rendered negative owing to the ready absorption of iodine by the volatile oil formed on preparing a decoction of mustard.

## Sinapis Albæ Semina.

**White Mustard Seed** is obtained from *Brassica alba*, Boissier (N.O. Cruciferae), a native of Europe. It is an erect annual plant, rather smaller than *Brassica sinapioides*, Roth., which it closely resembles, though the fruits of the two plants differ considerably in shape, those of white mustard being also more or less horizontal and hairy, while black mustard pods are erect and smooth. The fruits of the white mustard are spreading, bristly, rugged, roundish pods (siliquas), which are swollen where the seeds are situated, ribbed, and each provided with a very long sword-shaped (ensiform) beak. Each pod contains from four to six pale-yellow, exalbuminous seeds, about twice the diameter of black mustard seeds. The dried, ripe seeds are alone official. They possess rubefacient and vesicant properties, and are mixed with black mustard seeds, when powdered, to produce the official mustard.

**Characters.** — White mustard seeds are hard, pale yellow in colour, spheroidal in shape, about 2 Mm. in diameter, and 6·5 Mgm. in weight. The testa or seed-coat appears smooth, but when examined with a lens is seen to be covered with very minute pits and finely reticulated. The seeds become coated with mucilage when they are soaked in water, and the seed-coats can then easily be removed, revealing two folded yellow and oily cotyledons which embrace the small radicle. No endosperm is present. The seeds are inodorous, even when powdered; the slight odour developed when the powder is moistened with water is due to the formation of sinalbin mustard oil. The pungent taste of the seeds, which is much less marked than that of black mustard seed, is due to the same cause. Ash-yield, about 4 per cent.

**Notes.**—The seeds of white mustard contain mucilage in the epidermal cells of the seed-coat, about 30 per cent. of fixed oil in the cotyledons, and 25 per cent. of proteids. The fixed oil consists of the glycerides of oleic, stearic, and erucic or brassic acids. In addition, the seeds contain the crystalline glucoside sinalbin and the enzyme myrosin. In the presence of water the glucoside is hydrolysed by the myrosin, as represented in the following equation:—



The acrinyl or para-hydroxy-benzyl isothiocyanate constitutes white mustard oil. As it is only sparingly volatile with water vapour, it cannot be obtained by distillation, but must be extracted with boiling alcohol after the seed has been deprived of its fixed oil. Sinalbin mustard oil is soluble in dilute alkalis, has a burning taste, and forms blisters when applied to the skin, but much more slowly than the volatile oil of black mustard. When cold it possesses only a faint anise-like odour, but it gives off a pungent odour when heated. The oil can be prepared artificially by acting on p-hydroxy-benzylamine with carbon bisulphide. White mustard seeds contain no starch when ripe.

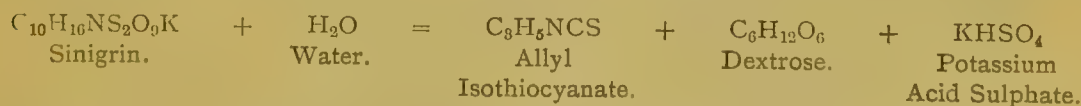


## Sinapis Nigræ Semina.

**Black Mustard Seed** is obtained from *Brassica sinapioides*, Roth. (N.O. Cruciferae), a native of Europe. It is an erect annual plant, about 1 M. or more in height, and is largely cultivated in England, Holland, Italy, Germany, and many other countries for the sake of the seed. The fruits of the plant are smooth, erect, flattened (appressed) siliquas, which dehisce by both sutures when ripe. Each pod is furnished with a short slender beak and contains about ten or twelve minute dark-coloured exalbuminous seeds, which are collected when ripe, and dried. They are much smaller than white mustard seeds, but possess similar properties, and are mixed with them, when powdered, to produce the official mustard.

**Characters.**—Black mustard seeds are hard, dark reddish-brown or greyish-brown in colour, spherical or slightly ovoid in shape, about 1 Mm. in diameter, and 1.3 Mgm. in weight. Sometimes the seeds are nearly black and they may be partially covered with a very thin whitish membranous coat. The testa or seed-coat is thin and brittle, and is seen to be covered with minute pits when examined with a lens, whilst the hilum can be distinguished as a paler-coloured point. The seeds become coated with mucilage when they are soaked in water, and the seed-coats can then easily be removed, revealing two folded greenish-yellow and oily cotyledons which embrace the small radicle. No endosperm is present. The seeds are inodorous even when powdered, but a strong pungent odour is developed when the powder is moistened with water, owing to the formation of volatile oil of mustard. The bitterness perceived when the seeds are first tasted, and probably due to sinigrin, is followed immediately by extreme pungency, caused by the volatile oil formed.

**Notes.**—Colchicum seeds differ from black mustard seeds in being larger, rougher, harder, and bitter, but not pungent. Black mustard seeds contain much less mucilage in the epidermal cells of the seed-coat than white mustard seeds, and only about 27 per cent. of fixed oil in the cotyledons. The fixed oil consists of the glycerides of oleic, stearic, erucic or brassic, and behenic acids. In addition, the seeds contain a small quantity of sinapine acid sulphate, together with the crystalline glucoside sinigrin (potassium myronate) and the enzyme myrosin, the last two substances being stored in separate cells. When they are brought in contact, in the presence of water, the glucoside is hydrolysed by the myrosin, as represented in the following equation:—

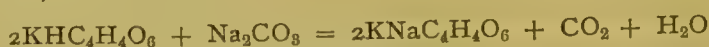


The formula of sinigrin is sometimes given as  $\text{C}_{10}\text{H}_{18}\text{NS}_2\text{O}_{10}\text{K}$ , the statement being also made that the decomposition of the glucoside does not involve reaction with a molecule of water and cannot, therefore, be described as a process of hydrolysis. The accuracy of that statement, however, seems very doubtful. After the ground mustard seed has been freed from its fixed oil by

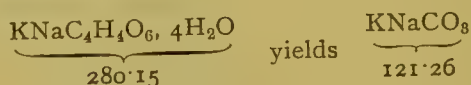
pressure, the pressed cakes are mixed with tepid water and allowed to undergo fermentation, after which they are distilled with steam. From 0.5 to 0.75 per cent. of volatile oil is obtained, consisting chiefly of allyl isothiocyanate, together with small and variable amounts of allyl cyanide, carbon bisulphide, and probably of the isomeric allyl thiocyanate. If the seeds be first subjected to a temperature exceeding 70° C. no fermentation takes place, because the myrosin is coagulated and cannot then act upon the sinigrin. The volatile oil of mustard can be prepared artificially by the interaction of allyl iodide and potassium thiocyanate in alcoholic solution, the allyl thiocyanate first formed being converted into the isothiocyanate by the influence of heat. Black mustard seeds resemble the white variety in containing no starch when ripe.

## Soda Tartarata.

**Sodium Potassium Tartrate**, usually known as Tartarated Soda, or Rochelle Salt,  $\text{KNaC}_4\text{H}_4\text{O}_6, 4\text{H}_2\text{O}$ , is prepared by neutralising acid potassium tartrate with sodium carbonate in presence of water and crystallising the resulting solution, thus—



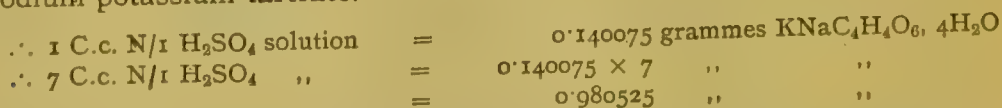
**Characters and Tests.**—Sodium potassium tartrate forms trimetric prisms with hemihedral facets. It is freely and entirely soluble in cold water (1 in 1.5), the solution having a saline taste, and affording the reactions characteristic of potassium, of sodium, and of tartrates. On heating 1 gramme of the tartrate to redness until gases (chiefly carbon monoxide) cease to be evolved an alkaline residue consisting of sodium potassium carbonate and carbon is left, and that, when treated with water, filtered, and well washed with water, should yield a clear, colourless filtrate, requiring for neutralisation not less than 7 C.c. of normal sulphuric acid solution; for



and since 121.26 grammes of  $\text{KNaCO}_3$  will neutralise 97.34 grammes  $\text{H}_2\text{SO}_4$  according to the equation



it follows that 1,000 C.c. of normal sulphuric acid solution, containing  $\frac{97.34}{2} = 48.67$  grammes  $\text{H}_2\text{SO}_4$ , will correspond to  $\frac{280.15}{2} = 140.075$  grammes of sodium potassium tartrate.

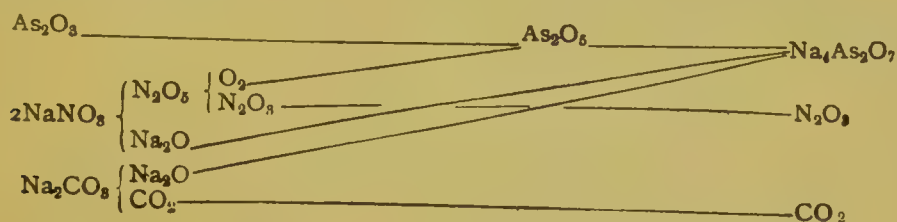


Equivalent to 98.05 per cent. purity in the 1 gramme taken for analysis.

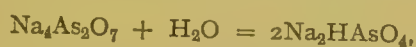
**Notes.**—The constitutional formula for Soda Tartarata, given in the Pharmacopœia, is discussed under Potassii Tartras. [*Dose.*—120 to 240 grains.]

## Sodii Arsenas.

**Sodium Arsenate** of the Pharmacopœia is the anhydrous salt, di-sodium hydrogen arsenate,  $\text{Na}_2\text{HAsO}_4$ , obtained by heating the crystallised salt to a temperature of  $149^\circ \text{C}$ ., until it ceases to lose moisture. The crystallised salt is obtained by the oxidation of arsenious anhydride in presence of sodium carbonate. The oxidising agent usually employed is sodium nitrate, the three compounds being fused together in a crucible till evolution of gas ceases. The fused mass contains sodium pyroarsenate, the nitrogen of the sodium nitrate being evolved as nitrous anhydride, or more probably as  $\text{NO}$  and  $\text{NO}_2$ . The oxygen of the nitrate converts the arsenious into arsenic anhydride, and this combines with sodium oxide from the sodium nitrate and carbonate to produce pyroarsenate of sodium—



The fused mass is then lixiviated with water, when the pyroarsenate combines with water to form the di-sodium hydrogen (ortho) arsenate—



and this salt crystallises with 12 molecules of water, part of which is, however, lost by efflorescence on exposure to the air, until the composition  $\text{Na}_2\text{HAsO}_4, 7\text{H}_2\text{O}$  is attained. To avoid the variations in potency which would follow from the employment of a salt containing variable proportions of water of crystallisation, the Pharmacopœia directs the anhydrous salt, as described above, to be employed for medicinal purposes. The removal of the water must be accomplished at the temperature mentioned, as at higher temperatures another molecule of water is removed with formation of sodium pyroarsenate.

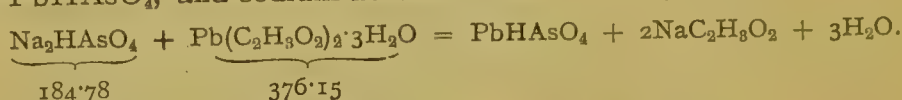
**Characters and Tests.**—Sodium arsenate is a white powder, soluble in 6 parts of cold water, the resulting solution having an alkaline reaction, although the salt is acid in constitution, *i.e.*, contains replaceable hydrogen,  $\text{Na}_2\text{HAsO}_4$ , because arsenic acid,  $\text{H}_3\text{AsO}_4$ , from which it is derived, contains three replaceable hydrogen atoms. The normal sodium salt would therefore be  $\text{Na}_3\text{AsO}_4$ ; this is not stable in aqueous solution but is partly hydrolysed into sodium hydroxide and the di-sodium hydrogen arsenate. Even the official salt, the di-sodium hydrogen arsenate, suffers this hydrolysis to some extent, and that is the cause of the alkaline reaction of the aqueous solution.



Sodium arsenate is only slightly soluble in hot or cold 90 per cent. alcohol. It affords the reactions characteristic of sodium and of arsenates, and should be



free from lead, copper, iron, aluminium, calcium, magnesium, potassium, ammonium, carbonates, chlorides, nitrates and sulphates. One gramme of pure sodium arsenate dissolved in 50 C.c. of water with 1 C.c. of glacial acetic acid, should require for complete precipitation 2.03 grammes of lead acetate. The acetic acid is added to prevent the formation of basic lead arsenate by the alkaline sodium arsenate solution. The precipitate produced has the formula  $\text{PbHAsO}_4$ , and sodium acetate is also formed, thus—



184.78 grammes of sodium arsenate are thus equivalent to 376.15 grammes of crystallised lead acetate,

$$\therefore 1 \text{ gramme } \text{Na}_2\text{HAsO}_4 = \frac{376.15}{184.78} = 2.0357 \text{ grammes of } \text{Pb}(\text{C}_2\text{H}_3\text{O}_2)_2 \cdot 3\text{H}_2\text{O}.$$

The official salt, being anhydrous, should not lose weight on exposure to a temperature of  $149^\circ \text{C}$ .

**Notes.**—It has been stated that 1 gramme of anhydrous sodium arsenate requires 3.05 grammes of crystallised lead acetate for complete precipitation, but that is only so in the absence of acetic acid, the statement being based on the incorrect assumption that the precipitate in the official test consists of normal lead arsenate,  $\text{Pb}_3(\text{AsO}_4)_2$ , and that acetic acid is also liberated by the reaction.

[Dose.— $\frac{1}{40}$  to  $\frac{1}{10}$  grain.]

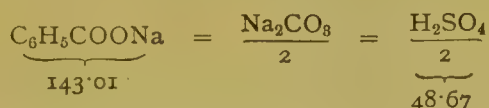
## Sodii Benzoas.

**Sodium Benzoate**,  $\text{C}_6\text{H}_5\text{COONa}$ , may be obtained by neutralising benzoic acid with sodium carbonate or bicarbonate in presence of water, and crystallising the solution of sodium benzoate so obtained, or evaporating it carefully to dryness.



**Characters and Tests.**—Sodium benzoate is a white, amorphous, or somewhat crystalline, powder, without odour or having a faint odour recalling that of benzoin, this character depending upon the source of the benzoic acid used in making the salt (*vide* Acidum Benzoicum). Sodium benzoate is soluble in less than 2 parts of cold water, in 24 parts of cold and in 12 parts of boiling 90 per cent. alcohol. The aqueous solution has a faint alkaline reaction, gives a yellowish or flesh-coloured precipitate of ferric benzoate on the addition of ferric chloride solution, and lets fall a crystalline precipitate of benzoic acid when acidulated with hydrochloric acid, provided the solution is sufficiently concentrated to yield benzoic acid in excess of the amount capable of remaining dissolved in the reaction mixture. It should be free from lead, copper, iron, calcium, magnesium, potassium, ammonium, and carbonates, and contain only traces of chlorides and sulphates. One gramme of the salt when heated, first melts (emitting the odour of benzoin if the benzoic acid has been derived from that source), then chars, and finally leaves a residue of sodium carbonate,

which, when dissolved in water, should require for neutralisation from 6.8 to 6.9 C.c. of normal sulphuric acid solution, for—



Therefore, 1,000 C.c. N/1  $\text{H}_2\text{SO}_4$  solution = 143.01 grammes  $\text{C}_6\text{H}_5\text{COONa}$

1 „ N/1  $\text{H}_2\text{SO}_4$  „ = 0.14301 „ „

6.8 „ N/1  $\text{H}_2\text{SO}_4$  „ = 0.9725 „ „

and 6.9 „ N/1  $\text{H}_2\text{SO}_4$  „ = 0.9868 „ „

or an average purity of 97.96 per cent.

**Notes.**—Commercial samples of sodium benzoate have been shown to contain an average of 4 per cent. of water, but that amount is in excess of what the Pharmacopœia permits. [Dose.—5 to 30 grains.]

## Sodii Bicarbonas.

**Sodium Bicarbonate**,  $\text{NaHCO}_3$ , may be obtained by two processes:—(1) By exposing crystals of sodium carbonate to the action of carbonic anhydride



Sodium carbonate crystals contain over 60 per cent. of water of crystallisation ( $\text{Na}_2\text{CO}_3, 10\text{H}_2\text{O}$ ), which is set free during the formation of the bicarbonate, rendering the reaction mixture semi-fluid, and this water cannot easily be removed by evaporation without decomposing the bicarbonate. Hence the sodium carbonate crystals are previously deprived of a portion of their water of crystallisation; or a mixture of dried carbonate and crystals is employed so that a smaller quantity of water is liberated which retains the more soluble sulphate and chloride of sodium present as impurities in the commercial carbonate. When this liquor is drained off a powdery residue of nearly pure bicarbonate is obtained. A solution of sodium carbonate is not employed because the sodium bicarbonate separates from this in a crystalline form which must afterwards be powdered. (2) By the “ammonia-soda” or Solvay process, which consists in passing ammonia gas into a strong sodium chloride solution and saturating it with carbonic anhydride. Ammonium bicarbonate is first formed—



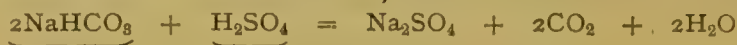
and this reacts with the sodium chloride, the sparingly soluble sodium bicarbonate being precipitated and ammonium chloride remaining in solution.



The precipitated bicarbonate is washed with cold water to remove adherent ammonium salts. This process will be more fully described under Sodii Carbonas.

**Characters and Tests.**—Sodium bicarbonate may occur in powder or in small white crystals. It has a saline taste, and is soluble in 11 parts of cold

water. One gramme should require from 11.8 C.c. to 11.9 C.c. of normal sulphuric acid solution for neutralisation, thus—



$$2 \times 83.43 \quad 97.34$$

Therefore, 1,000 C.c. N/1  $\text{H}_2\text{SO}_4$  solution = 83.43 grammes  $\text{NaHCO}_3$

1 „ N/1  $\text{H}_2\text{SO}_4$  „ = 0.08343 „ „

11.8 „ N/1  $\text{H}_2\text{SO}_4$  „ = 0.9845 „ „

and 11.9 „ N/1  $\text{H}_2\text{SO}_4$  „ = 0.9928 „ „

which is equivalent to an average purity of 98.86 per cent. The salt affords the reactions characteristic of sodium and of bicarbonates, should be free from lead, copper, iron, aluminium, calcium, magnesium, potassium, sulphites, and thiosulphates (*vide* Sodii Carbonas for origin of these last two impurities), and contain only traces of chlorides, sulphates, and ammonium salts. The bicarbonate is distinguished from the normal carbonate by its solution in cold water (hot water decomposes the bicarbonate into carbonate and carbonic acid), giving only a white opalescence or precipitate with solution of mercuric chloride, which is slowly converted into a reddish-brown precipitate of oxychloride of mercury on standing, while the normal carbonate gives this reddish-brown precipitate immediately. This test, in the form given in the Pharmacopœia, is untrustworthy, because a dilute solution of sodium bicarbonate undergoes partial decomposition into normal carbonate rapidly at comparatively low temperatures, particularly if agitated, and the reaction is also influenced by the relative proportion of mercuric chloride employed. Another test is as follows:—Two drops of phenol-phthalein solution added to a solution freshly prepared from 1 gramme of the salt in 20 C.c. of water at a temperature not above 15° C., and without agitation, will indicate the presence of more than traces of normal carbonate by the production of a red colour. A solution of sodium bicarbonate, to which a slight excess of hydrochloric acid has been added to convert it into chloride (because the bicarbonate gives a precipitate with ferric chloride which obscures the reaction) should give no red colour on the addition of ferric chloride solution, showing absence of thiocyanates. For the origin of thiocyanates see “Sodii Carbonas.”

**Notes.**—Twenty parts of sodium bicarbonate should be neutralised by 16.7 parts of citric acid, or 17.8 of tartaric acid. The slight solubility of sodium bicarbonate compared with most other sodium salts should be carefully noted for purposes of practical dispensing. Since aqueous solutions of the salt are decomposed gradually at ordinary temperatures, it should never be kept in this form, nor should the salt be added to infusions or other vehicles until these are cold, because the rate of decomposition is accelerated by heat, and rapidly completed at 70° C.

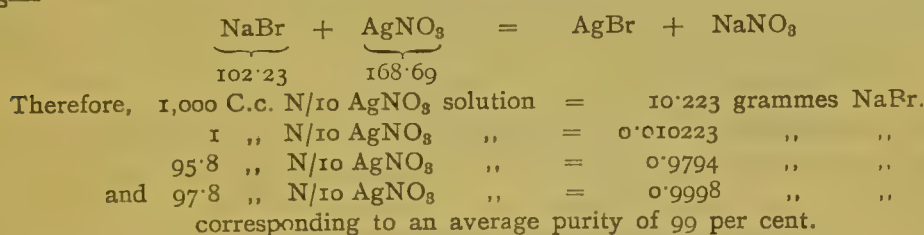
[Dose.—5 to 30 grains.]

## Sodii Bromidum.

**Sodium Bromide**,  $\text{NaBr}$ , may be prepared in the manner described under Potassii Bromidum, using sodium hydroxide in place of potassium hydroxide. In order to obtain the anhydrous salt the solution is crystallised above 50° C., since below that temperature crystals of a salt having the formula,  $\text{NaBr} \cdot 2\text{H}_2\text{O}$ , are obtained.



**Characters and Tests.**—Sodium bromide forms small, white, cubic crystals, which are inodorous and slightly deliquescent. It has a saline taste and is soluble in 1·2 parts of water, or in 16 parts of 90 per cent. alcohol. It affords the reactions characteristic of sodium and of bromides, should be free from lead, copper, arsenium, iron, aluminium, zinc, calcium, magnesium, potassium, ammonium, carbonates, cyanides, bromates, and iodates, and contain only the slightest traces of iodides, chlorides, or sulphates. One gramme of the dry salt dissolved in water should require for complete precipitation not less than 95·8 C.c. nor more than 97·8 C.c. of decinormal silver nitrate solution, thus—



If more than 97·8 C.c. of silver solution be required presence of more than traces of chloride are indicated, since sodium chloride precipitates more silver nitrate than an equal weight of bromide. If less than 95·8 C.c. be required it may be due to iodide, other impurities which do not precipitate silver nitrate (*e.g.*  $\text{Na}_2\text{SO}_4$ ), or moisture. An aqueous solution of the bromide should give no red coloration on the addition of ferric chloride solution, unless the latter be added in excess, thus showing the absence of thiocyanates (*vide* Potassii Bromidum and Sodii Carbonas).

**Notes.**—Sodium bromide readily absorbs 3 or 4 per cent. of moisture from the air. [Dose.—5 to 30 grains.]

## Sodii Carbonas.

**Sodium Carbonate**,  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ , is obtained from sodium chloride by two processes: (1) The Leblanc process. Sodium chloride is strongly heated with sulphuric acid and converted into sodium sulphate, the hydrochloric acid evolved being collected in water and employed in the production of chlorine and for other purposes—



or, the sodium chloride and sulphuric acid are first mixed in molecular proportions, and the resulting acid sodium sulphate then strongly heated with an equal molecular proportion of sodium chloride. The sodium sulphate is then mixed with coal and calcium carbonate (limestone or chalk) and strongly heated in a furnace. The sulphate is thereby reduced to sulphide, and this reacts with the calcium carbonate to form calcium sulphide and sodium carbonate—



The heated mass is allowed to cool and then lixiviated with water, which extracts the soluble sodium carbonate. This solution is boiled down and, while boiling, crystals having the composition  $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$  are deposited and con-

tinually raked out, more soda lye being added from time to time. This impure carbonate is then dissolved in hot water, clarified, and allowed to cool, when crystals having the composition of the official salt,  $\text{Na}_2\text{CO}_3, 10\text{H}_2\text{O}$ , are deposited. Although the equations given above express the chief reactions which occur during the process other numerous and complicated reactions take place during the heating, the cooling of the ignited product, and its lixiviation. Thus, some of the calcium carbonate is converted into oxide during the latter stages of heating—



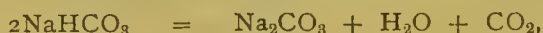
This calcium oxide gives rise later on to calcium hydroxide by combination with water, and this decomposes some of the sodium carbonate solution with formation of sodium hydroxide—



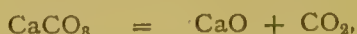
The calcium oxide also prevents the calcium sulphide from dissolving and so decomposing the sodium carbonate which it would otherwise do, according to the equation—



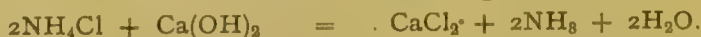
The retention of the calcium sulphide in the portion insoluble in water is probably due to the formation of an insoluble oxysulphide  $\text{CaO}, 2\text{CaS}$ . During the cooling of the heated mass some of the sulphide is oxidised to sulphite and thio-sulphate (*vide* Tests, below). Other by-products are various cyanogen compounds which originate during the heating process through the combination of atmospheric nitrogen with the carbon in presence of alkali. During the subsequent exposure to air, and during cooling and lixiviation, some thiocyanate is formed by complicated reactions between the cyanogen and sulphur compounds—hence the test for absence of thiocyanate in the official salt, and other sodium salts prepared directly or indirectly from it. (2.) The “ammonia” or Solvay process was briefly described under “Sodii Bicarbonas.” In order to obtain normal sodium carbonate the bicarbonate obtained by this process is heated—



and the anhydrous carbonate dissolved in water and crystallised in order to obtain the salt  $\text{Na}_2\text{CO}_3, 10\text{H}_2\text{O}$ . The carbonic anhydride obtained in this way may be used again to convert a fresh portion of sodium chloride into bicarbonate, while the ammonium chloride solution from which the sodium bicarbonate has been separated is heated with lime. The ammonia gas so evolved is also employed again, so that the process is continuous. In practice the theoretical conditions cannot be entirely realised, a portion of the ammonia and carbonic anhydride being lost. The extra carbonic anhydride required is obtained by heating chalk or limestone—



and the calcium oxide (quicklime) so obtained is used for the recovery of the ammonia from the ammonium chloride mother-liquor—



**Characters and Tests.**—Sodium carbonate occurs in transparent, colourless, rhombic crystals which effloresce on exposure to air and have a harsh and

strongly alkaline taste. It is soluble in less than 2 parts of water, but insoluble in strong alcohol. Though it should respond to the qualitative tests given under Sodii Bicarbonas, its aqueous solution gives an immediate precipitate of oxy-chloride of mercury on the addition of mercuric chloride solution. When heated it liquefies, and above 80° C. loses the whole of its water of crystallisation, leaving a residue of anhydrous carbonate. This corresponds to a loss of 62·93 per cent. of its weight, for

$$\begin{array}{rcccl} \text{Na}_2\text{CO}_3, 10\text{H}_2\text{O} & : & \text{Na}_2\text{CO}_3 & :: & 100 : 37\cdot07 \\ \hline 284\cdot11 & & 105\cdot31 & & \\ \text{and } 100 - 37\cdot07 & = & & & 62\cdot93 \end{array}$$

Each gramme of the crystallised salt should require for neutralisation at least 6·9 C.c. normal sulphuric acid solution—



Therefore 1,000 C.c. N/1 H<sub>2</sub>SO<sub>4</sub> solution =  $\frac{284\cdot11}{2}$  grammes Na<sub>2</sub>SO<sub>4</sub>, 10H<sub>2</sub>O.

$$\begin{array}{rcccl} & & = & 142\cdot055 & \text{,,} \\ 1 \text{ C.c. N/1 H}_2\text{SO}_4 & \text{,,} & = & 0\cdot142055 & \text{,,} \\ 6\cdot9 \text{ C.c. N/1 H}_2\text{SO}_4 & \text{,,} & = & 0\cdot9802 & \text{,,} \\ & & \text{equivalent to } 98\cdot02 \text{ per cent. purity.} & & \end{array}$$

**Notes.**—Crystallised sodium carbonate readily loses water on exposure to air, the crystals falling to powder, which contains 5 instead of 10 molecules of water of crystallisation. When heated to about 50° C. more water is lost until the salt attains the composition Na<sub>2</sub>CO<sub>3</sub>,H<sub>2</sub>O, while above 80° C. the last molecule of water is expelled. When taking a sample for volumetric determination a large crystal should be broken, and the desired quantity selected from the clear, glassy, central portion. [Dose.—5 to 30 grains.]

## Sodii Carbonas Exsiccatus.

**Exsiccated Sodium Carbonate**, the anhydrous normal carbonate, Na<sub>2</sub>CO<sub>3</sub>, may be obtained by heating any of the various forms of crystalline sodium carbonate to expel the water of crystallisation. If the official Sodii Carbonas be heated, it loses nearly 63 per cent. of its weight corresponding to the formula Na<sub>2</sub>CO<sub>3</sub>, 10H<sub>2</sub>O. Anhydrous sodium carbonate is also obtained commercially by heating the bicarbonate precipitated in the “ammonia-soda” process, or by heating the salt, Na<sub>2</sub>CO<sub>3</sub>, H<sub>2</sub>O, which is obtained by the evaporation of the soda-lye of the Leblanc process (*vide* Sodii Carbonas, methods of preparation).

**Tests.**—Exsiccated sodium carbonate affords the reactions characteristic of sodium and carbonates. When strongly heated it should yield only traces of water, which the anhydrous salt always takes up from the air when kept under ordinary conditions.

**Notes.**—Anhydrous sodium carbonate should be kept in well-closed vessels, since it readily absorbs moisture from the air, the water combining with it to form one of the numerous compounds containing water of crystallisation. [Dose.—3 to 10 grains.]



## Sodii Chloridum.

**Sodium Chloride**, NaCl, is common salt, purified. Pure sodium chloride may be obtained by neutralising sodium carbonate or bicarbonate solution with hydrochloric acid. If the solution be allowed to crystallise slowly, large cubical crystals are obtained, which are very apt to include portions of the mother liquor in their interior; hence it is better to evaporate the solution with constant agitation, which causes the sodium chloride to separate in the usual crystalline grains. Pure sodium chloride may also be prepared by passing hydrochloric acid gas into a strong aqueous salt solution. The salt being only slightly soluble in aqueous solutions of hydrochloric acid, separates in sandy grains, leaving the accompanying impurities in the liquid. By filtration and recrystallisation, very pure sodium chloride is obtained.

**Characters and Tests.**—Sodium chloride occurs in white, crystalline grains or transparent, cubic crystals, free from moisture. Decrepitation when the crystals are heated indicates the inclusion of mother-liquor in their interior. The salt is soluble in less than 3 parts of cold water, not much more soluble in hot water, and only very slightly soluble in alcohol. It affords the reactions characteristic of sodium and chlorides, should be free from potassium, bromides, and iodides, and contain only slight traces of calcium, magnesium, or sulphates.

**Notes.**—When pure, sodium chloride undergoes no change in the air, but it is frequently contaminated with magnesium chloride, and is then deliquescent. The tendency of ordinary "table salt" to attract moisture can be prevented by the addition of calcium phosphate, and it may perhaps be checked by the addition of a small quantity of sodium phosphate, since that compound converts the deliquescent magnesium chloride into phosphate.

## Sodii Citro-Tartras Effervescens.

**Effervescent Sodium Citro-Tartrate** is a granular preparation obtained by heating sodium bicarbonate, citric and tartaric acids, and sugar previously powdered and well mixed. At a temperature of about 100° C., the mixture becomes very slightly moist and agglomerates to granular lumps, which are separated by sieves from ungranulated powder. That is worked up with the next batch of material whilst the selected granules are carefully dried. If stored in a damp condition reaction slowly takes place between the bicarbonate and the acids, and the preparation becomes deficient in effervescing properties. The proportions of bicarbonate and acids in the official formula are adjusted so that the product when acted upon by water yields a slightly acid draught, which has a more refreshing and agreeable flavour than one which is neutral or alkaline. Taking the neutralising power of tartaric and citric acids given under the characters of Sodii Bicarbonas—

$$27 \text{ ozs. of tartaric acid will neutralise } \frac{20 \times 27}{17.8} = 30.3 \text{ ozs. NaHCO}_3$$

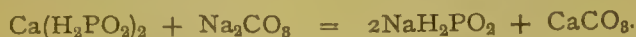
$$\text{and } 18 \text{ ozs. of citric acid will neutralise } \frac{20 \times 18}{16.7} = 21.6 \text{ ozs. NaHCO}_3$$

now  $30.3 + 21.6 = 51.9$  ozs., while the weight of sodium bicarbonate in the official formula is 51 ozs.

[Dose.—60 to 120 grains.]

## Sodii Hypophosphis.

**Sodium Hypophosphite**,  $\text{NaH}_2\text{PO}_2$ , may be obtained by mixing solutions of calcium hypophosphite and sodium carbonate—



The precipitate of calcium carbonate is removed by filtration, and the filtrate carefully evaporated to dryness at a low temperature. Sodium hypophosphite may be formed directly from phosphorus by the action of sodium hydroxide in a manner similar to that described under calcium hypophosphite. It is, however, difficult to purify from the soluble sodium phosphate, always formed during this process, nor can the excess of sodium hydroxide be removed so simply as the calcium hydroxide. The secondary reactions which occur in the reaction between phosphorus and sodium hydroxide are chiefly due to the action of the hydroxide on the hypophosphite. Those reactions occur to a much smaller extent in the preparation of the calcium salt, owing to the sparing solubility of calcium hydroxide, and any calcium phosphate formed in these secondary reactions is easily separated from the hypophosphite, owing to its insolubility. For the same reason, the reaction between phosphorus and calcium hydroxide is not so violent and dangerous as that between phosphorus and sodium hydroxide, and the yield from a given weight of phosphorus is proportionately greater.

**Characters and Tests.**—Sodium hypophosphite is a deliquescent white, granular salt, with a bitter, nauseous taste. It is soluble in less than 1 part of water and in 30 parts of 90 per cent. alcohol, insoluble in ether. When heated in air, it undergoes a complicated decomposition: a part of the hypophosphite is oxidised to (meta- and pyro-) phosphate by another part, which is thereby reduced to inflammable hydrogen phosphide, some hydrogen being also set free. A similar case of mutual oxidation and reduction between molecules of the same composition is seen in the conversion of manganates into permanganates, with simultaneous production of a lower oxide of manganese (compare Potassii Permanganas). It is easily attacked by oxidising agents, sodium phosphate being usually formed. Owing to the readiness with which this change occurs, the hypophosphites constitute powerful reducing agents. Thus, a solution of sodium hypophosphite when heated with copper sulphate solution becomes phosphate; it takes up oxygen from the water, the hydrogen of which then displaces the copper—



The copper combines with more hydrogen to form cuprous hydride,  $\text{CuH}$ , which has a red colour resembling that of copper. It is unstable, and decomposes into its constituents when the mixture is boiled, hydrogen gas being evolved. The quantitative determination of purity is made by means of potassium permanganate in the manner described under "Calcii Hypophosphis" (see page 103). According to the official requirements, 0.5 gramme of the sodium salt in 25 C.c. of water should be capable of reducing 1.15 gramme of



potassium permanganate when the mixture is boiled for ten minutes, the complete reduction being indicated by the absence of pink tint in the filtrate. The reaction is similar to that already described for the calcium salt.

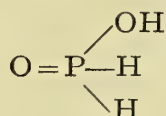


and by this equation—

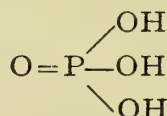
$$\frac{4\text{KMnO}_4}{4 \times 156.87} : \frac{3\text{NaH}_2\text{PO}_2}{3 \times 87.44} :: 1.15 : .4808$$

0.4808 gramme in the 0.5 gramme taken for analysis corresponds to a purity of 96.16 per cent., a standard which is seldom reached by commercial samples. Sodium hypophosphite should be free from lead, copper, iron, aluminium, zinc, calcium, magnesium, potassium, ammonium, chlorides, and sulphates, and contain only traces of carbonates. Its aqueous solution should give little or no precipitate on the addition of lead acetate, which limits the presence of phosphates and phosphites, the test being based upon the insolubility of lead phosphate and phosphite in water. Traces of those impurities are almost inevitable in the commercial salt, since the hypophosphite is so easily oxidised, but most trade specimens give a considerable precipitate with lead acetate.

**Notes.**—The official characters and tests refer to the anhydrous salt obtained by evaporating the solution to dryness in manufacture. If crystallised from water or alcohol containing some water, it has the formula  $\text{NaH}_2\text{PO}_2 \cdot \text{H}_2\text{O}$ , and is still deliquescent. Crystallisation from alcohol is a good method of purification. The commercial salt seldom responds to the official permanganate test, partly on account of the phosphate and phosphite, and also because the anhydrous salt so readily absorbs moisture from the air. The formula of hypophosphorous acid is written usually  $\text{HPH}_2\text{O}_2$  and not  $\text{H}_3\text{PO}_2$ . The separation of the hydrogen atoms in the formula indicates that only one of the three is replaceable by metals to form salts, and from this fact and certain other considerations the constitution of the acid is usually regarded as—



which shows why one of the three hydrogen atoms behaves differently to the other two, this replaceable hydrogen being combined in a hydroxyl group, while the remaining two are linked directly to the phosphorus. On the other hand phosphoric acid is tribasic, because all three hydrogen atoms are in the hydroxylic condition, thus—



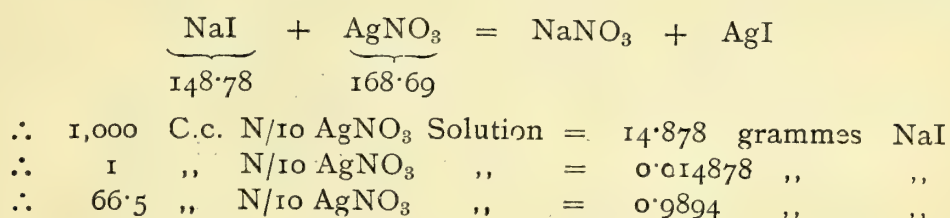
Consequently the hypophosphite radical,  $\text{PH}_2\text{O}_2$ , is monobasic; the sodium salt has the formula  $\text{Na}(\text{PH}_2\text{O}_2)$ , and the calcium salt the formula  $\text{Ca}(\text{PH}_2\text{O}_2)_2$ . Compare the notes under *Calcii Hypophosphis*. [Dose.—3 to 10 grains.]



## Sodii Iodidum.

**Sodium Iodide**, NaI, may be prepared from iodine and sodium hydroxide by a process similar to that described for potassium bromide; or iodine may be digested with iron and the resulting solution of iodide of iron precipitated with sodium carbonate. A precipitate of hydrated oxide of iron is formed, carbon dioxide evolved, while a solution of sodium of iodide remains. This may be evaporated and crystallised. The best results are obtained by using the iodine in the proportion 2 Fe: 5I to yield  $\text{FeI}_2$ ,  $\text{FeI}_3$ , since in this case the iron separates rapidly and completely as hydrated magnetic oxide. Sodium iodide should be crystallised from warm solutions—above  $68^\circ \text{C}$ ., since a salt containing two molecules of water,  $\text{NaI} \cdot 2\text{H}_2\text{O}$ , separates at lower temperatures. In the official monograph the temperature for crystallisation is given as  $68^\circ \text{F}$ .: that appears to be an error, and may account for the more or less hydrated condition of trade samples.

**Characters and Tests.**—Sodium iodide is a dry, white, crystalline powder, with a tendency to deliquescence, and a saline and somewhat bitter taste. It is soluble in less than its weight of water and in three parts of 90 per cent. alcohol. It affords the reactions characteristic of sodium and of iodides, should be free from lead, copper, arsenium, iron, aluminium, calcium, magnesium, potassium, ammonium, bromates, cyanides, carbonates, and iodates, and contain only traces of bromides, chlorides or sulphates. The salt readily absorbs water from the air, but when dried at  $120^\circ \text{C}$ . it should not lose more than 5 per cent. moisture. Each gramme of this dried salt should require not less than 66.5 C.c. of decinormal silver nitrate solution for complete precipitation—



Equivalent to a purity of 98.94 per cent. excluding the moisture which may be present.

**Notes.**—The anhydrous sodium iodide, like the hydrous salt,  $\text{NaI} \cdot 2\text{H}_2\text{O}$ , is deliquescent, but the latter salt containing already nearly 20 per cent. of water of crystallisation would soon become liquefied by absorption of water from the air. For this reason and for the sake of uniformity with the other alkali iodides, bromides, and chlorides, the anhydrous salt is preferred. The limit for moisture in the official test is intended to prevent the introduction of an undue proportion of water in a somewhat expensive substance. In interpreting the results of the volumetric determination it should be remembered that the presence of bromides or chlorides may cause the volume of silver nitrate solution to exceed the quantity required for pure sodium iodide. The absence of more than traces of those bodies must be therefore proved by careful qualitative testing. [Dose.—5 to 20 grains.

## Sodii Nitris.

**Sodium Nitrite**,  $\text{NaNO}_2$ , may be obtained by fusing sodium nitrate with metallic lead, gradually added in small fragments—



The conversion of nitrate into nitrite by loss of oxygen may be effected by heat alone, but the change can be effected more readily, and at a lower temperature, by the employment of reducing agents. Lead constitutes a useful reducing agent in the present case, because it forms an oxide which readily separates from the layer of fused nitrite. The fused layer may be poured off into moulds to solidify, but probably requires purification by solution, and crystallisation from water. If the temperature of fusion be allowed to rise too high the formation of sodium oxide occurs, and this forms a soluble compound with some lead oxide. The solution of the fused mass must then be carefully neutralised with a dilute acid, which neutralises the caustic soda present, and the lead held in solution by it is then nearly all precipitated.

**Characters and Tests.**—Sodium nitrite is a deliquescent, white, crystalline powder, very soluble in water (1 in 1·4). Its aqueous solution should be neutral, or only faintly alkaline. One tenth (0·1) of a gramme dissolved in water and treated with dilute sulphuric acid and potassium iodide in a brine-charged nitrometer (*vide* Spiritus Ætheris Nitrosi) should liberate not less than 32·5 C.c. of nitric oxide, measured at 15·5°C., and 760 Mm. pressure, corresponding to not less than 95 per cent.,  $\text{NaNO}_2$  (more exactly 94·5).



Therefore, 68·58 grammes pure  $\text{NaNO}_2$  will liberate 29·82 grammes of nitric oxide, measuring 22·32 litres at 0°C and 760 Mm. pressure.

and 0·1 gramme pure  $\text{NaNO}_2$  will liberate—

$$\frac{22\cdot32 + 1000 + (273 + 15\cdot5)}{10 + 68\cdot58 + 273} \text{ C.c. of NO measured at } 15\cdot5^\circ\text{C} = 34\cdot39 \text{ C.c.}$$

$$\text{And } 34\cdot39 : 32\cdot5 :: 100 : 94\cdot5.$$

That is, if the nitrite be pure, 0·1 gramme will yield under the given conditions 34·39 C.c., but if it contain only 94·5 per cent. of  $\text{NaNO}_2$ , then 32·5 C.c. will be obtained. An aqueous solution should not give more than the faintest precipitate on the addition of diluted sulphuric acid, showing that the salt has been purified from lead in the manner described above. If any lead be present it will be precipitated as the insoluble sulphate,  $\text{PbSO}_4$ .

**Notes.**—The small dose of sodium nitrite should be carefully noted; no other sodium salts, except such as the arsenate, which contains a poisonous metal, have such a powerful action. Sodium nitrite, like ethyl and amyl nitrites, affects the peripheral circulation. It is difficult to avoid the presence of traces of lead and caustic soda in the commercial salt; hence, the slight allowance for those impurities in the official tests. [*Dose.*—1 to 2 grains.

## Sodii Phosphas.

**Sodium Phosphate**,  $\text{Na}_2\text{HPO}_4$ ,  $12\text{H}_2\text{O}$ , is obtained from bone-ash, which consists chiefly of normal calcium phosphate  $\text{Ca}_3(\text{PO}_4)_2$ . This is treated with



sulphuric acid which dissolves the normal phosphate, forming a soluble acid calcium phosphate  $\text{CaH}_4(\text{PO}_4)_2$

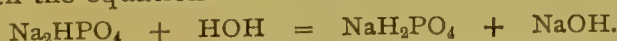


The calcium sulphate formed by this reaction (as well as that produced by the action of the sulphuric acid on the calcium carbonate which also occurs in bone ash) being sparingly soluble is mostly removed by diluting and filtering the solution of acid calcium phosphate. To the filtrate sodium carbonate is added until an alkaline reaction is obtained; under these conditions a solution of sodium phosphate is obtained from which the calcium carbonate is removed by filtration.

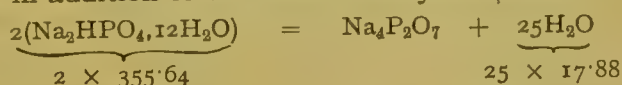


The filtrate evaporated and allowed to crystallise below  $35^\circ \text{C}$ . deposits crystals having 12 molecules of water of crystallisation. Above  $35^\circ \text{C}$ . a salt containing 7 molecules of water separates out.

**Characters and Tests.**—Sodium phosphate occurs in colourless rhombic prisms. Exposed to air it effloresces and finally attains the composition  $\text{Na}_2\text{HPO}_4, 7\text{H}_2\text{O}$ . It is soluble in 7 parts of water. Its aqueous solution has a saline taste and an alkaline reaction in spite of the fact that it is an acid salt in constitution, *i.e.*, only two of the three characteristic hydrogen atoms of the phosphoric acid,  $\text{H}_3\text{PO}_4$ , are replaced by sodium. The alkaline reaction of the aqueous solution is probably due to a partial hydrolysis of the di-sodium salt in accordance with the equation—



It affords the reactions characteristic of sodium and of phosphates, should be free from potassium, ammonium, or carbonates, and contain only traces of sulphates or chlorides. Heated to a dull redness it is converted into sodium pyrophosphate, 2 molecules of the anhydrous orthophosphate losing one molecule of water in addition to the water of crystallisation.



This corresponds to a loss in weight of 62.84 per cent., because—

$$711.28 : 447.00 :: 100 : 62.84$$

If heated to  $100^\circ$ — $120^\circ$ , the crystals lose their water of crystallisation only, and the anhydrous ortho-di-sodium hydrogen phosphate is obtained,  $\text{Na}_2\text{HPO}_4$ .

**Notes.**—There are three sodium orthophosphates obtained by replacing one, two, or three atoms of hydrogen in the tribasic ortho-phosphoric acid—

$\text{H}_3\text{PO}_4$	..	..	phosphoric acid.
$\text{NaH}_2\text{PO}_4$	..	..	sodium di-hydrogen phosphate.
$\text{Na}_2\text{HPO}_4$	..	..	di-sodium hydrogen phosphate.
$\text{Na}_3\text{PO}_4$	..	..	tri-sodium (or normal) phosphate.

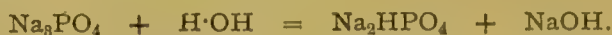
If solutions of phosphoric acid are treated with sodium hydroxide or carbonate in the relative proportion represented by



and the solution be concentrated to crystallisation the di-sodium hydrogen phosphate separates, because the tri-sodium salt, which we might expect to



obtain, is hydrolysed in aqueous solution into the di-sodium salt and sodium hydroxide—



In order to obtain the tri-sodium salt the acid and base must be fused together, *i.e.*, combination must occur in the absence of water. The salt, even when so formed, appears to undergo the hydrolysis described above, when it is dissolved in water, because its solution yields only crystals of the di-sodium salt and a strongly alkaline mother liquor containing NaOH. In order to obtain the mono-sodium salt the acid must be kept in decided excess during the crystallisation of its solution. The crystallisation of the di-sodium salt appears to be facilitated by the presence of a distinct excess of alkali probably because the presence of the alkali diminishes, in accordance with the laws of mass action, the hydrolytic action of the water. According to this law the reaction



will be prevented or retarded if one of its products, *viz.*, NaOH, be already present in the solution.

[*Dose.*—30 to 120 grains (repeated) ;  $\frac{1}{4}$  to  $\frac{1}{2}$  ounce (single).]

## Sodii Phosphas Effervescens.

**Effervescent Sodium Phosphate** is prepared by mixing sodium phosphate, previously rendered nearly anhydrous by drying until it has lost 60 per cent. of its weight, with sodium bicarbonate and citric and tartaric acids, all in powder. The mixture is then heated and granulated as described under Sodii Citro-Tartras Effervescens. It is necessary to use anhydrous sodium phosphate; otherwise the water of crystallisation will be set free when heat is applied, and that will be sufficient to bring about the reaction between the sodium bicarbonate and the acids. It will be seen that the proportion of sodium bicarbonate to the citric and tartaric acids is rather less than that in the formula for the sodium citro-tartrate: this is on account of the alkaline reaction of the sodium phosphate itself, a point which has been referred to fully under Sodii Phosphas.

[*Dose.*—60 to 120 grains (repeated) ;  $\frac{1}{4}$  to  $\frac{1}{2}$  ounce (single).]

## Sodii Salicylas.

**Sodium Salicylate**,  $\text{C}_6\text{H}_4(\text{OH})\text{COONa}$ , may be obtained by neutralising salicylic acid suspended in water, with sodium bicarbonate, carbonate, or hydroxide. The solution is evaporated to dryness and the residue may be crystallised from alcohol. The crystals are said to be anhydrous, although the official formula includes one molecule of water to two of salicylate,  $[\text{C}_6\text{H}_4(\text{OH})\text{COONa}]_2, \text{H}_2\text{O}$ . This may be expressed in simpler terms as  $\text{C}_6\text{H}_4(\text{OH})\text{COONa}, \frac{1}{2}\text{H}_2\text{O}$ . The preparation and reactions of salicylic acid will be found under Acidum Salicylicum.

**Characters and Tests.**—Sodium salicylate occurs in small colourless scales, or in tabular crystals with a pearly lustre, and a sweetish, saline, and

rather unpleasant taste, but no odour. It is soluble in less than its own weight of water and in 6 parts of 90 per cent. alcohol. The solutions should be neutral or slightly acid to litmus; if alkaline they rapidly darken by oxidation. When heated to redness the salt is decomposed, evolving inflammable gases and yielding eventually a white ash of sodium carbonate which effervesces on the addition of acids and imparts the yellow colour, characteristic of sodium, to flame. Ferric chloride added to a strong solution of sodium salicylate gives a reddish brown, and to a dilute solution a violet colour due to the formation of iron salicylate. Solutions, not too dilute (containing over 1 per cent. of the salt), give a yellowish-brown precipitate (uranium salicylate) with solution of uranium acetate: this test serves to distinguish salicylates from carbolates and sulphocarbulates, which do not form an insoluble uranium salt under those conditions. The salt should be free from phenol, either introduced as an impurity with the salicylic acid, or resulting from the decomposition of the salt (this is favoured by the presence of free alkali). If phenol be present, it may be detected by its odour on opening a well-stoppered vessel in which 50 or 100 grammes of the salt has been kept for some time. An aqueous solution of sodium salicylate throws out a precipitate of salicylic acid when rendered acid with nitric acid, owing to the sparing solubility of the acid in water. On gradually adding alcohol the salicylic acid redissolves, and, on adding to separate portions of the clear liquid solutions of silver nitrate and barium chloride respectively, no precipitates should be produced, showing absence of chlorides and sulphates. The alcohol is added so that the precipitate of salicylic acid formed on the addition of the nitric acid may not obscure the subsequent reactions. Cold sulphuric acid dissolves the salt without charring it or evolving any gas, the absence of numerous and different kinds of organic impurities being thus indicated.

**Notes.**—The acid liberated from sodium salicylate and recrystallised should accord with all the official requirements for Acidum Salicylicum, and the remarks on the purity of that acid (see page 34) apply equally to the sodium salt.

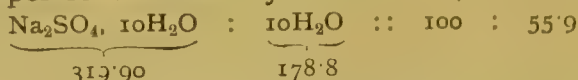
[Dose.—10 to 30 grains.

## Sodii Sulphas.

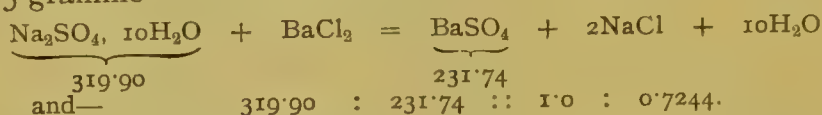
**Sodium Sulphate** or **Glauber's Salt**,  $\text{Na}_2\text{SO}_4, 10\text{H}_2\text{O}$ , is obtained by the action of sulphuric acid on sodium chloride, as in the first stage of sodium carbonate manufacture by the Leblanc process. It is also obtained as a by-product in the manufacture of nitric acid from Chili saltpetre and sulphuric acid, and in many other industrial processes; it occurs also native as Thenardite,  $\text{Na}_2\text{SO}_4$ , Glauberite, a double sulphate of sodium and calcium,  $\text{Na}_2\text{SO}_4, \text{CaSO}_4$ , and Astrakanite,  $\text{Na}_2\text{SO}_4, \text{MgSO}_4, 4\text{H}_2\text{O}$ . It is found in considerable quantities in many mineral waters such as Carlsbad and Pullna.

**Characters and Tests.**—Sodium sulphate forms transparent, monoclinic prisms, which effloresce on exposure to the air. It has a saline and bitter taste, is soluble in 2.5 parts of water at  $15.5^\circ \text{C}$ ., and in less than half its weight at  $25^\circ$  to  $30^\circ \text{C}$ . Saturated solutions, when heated to boiling, deposit crystals of the anhydrous sulphate,  $\text{Na}_2\text{SO}_4$ . The crystals readily become

anhydrous when heated; when rendered quite anhydrous, the loss in weight corresponds to 55.9 per cent. of the crystallised salt, for



It affords the reactions characteristic of sodium and of sulphates, should be free from lead, iron, arsenium, aluminium, calcium, magnesium, potassium, ammonium, and carbonates, and contain only the slightest traces of chlorides. One gramme of the crystallised salt, dissolved in water acidulated with hydrochloric acid, should give, on the addition of barium chloride solution, a white precipitate of barium sulphate, which, when washed and dried, should weigh 0.725 gramme—



**Notes.**—The solution of sodium sulphate should be heated to boiling before adding the barium chloride; this causes the barium sulphate precipitate to aggregate, so that it is more readily filtered out. The addition of hydrochloric acid assists this aggregation, and also nearly entirely prevents the barium sulphate carrying some of the alkaline salt down with it. Under the best conditions the barium sulphate usually retains a trace of alkaline salt even after washing, so that the observed weight is slightly greater than that calculated from the equation.

[Dose.—30 to 120 grains (repeated);  $\frac{1}{4}$  to  $\frac{1}{2}$  ounce (single).]

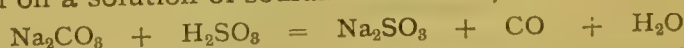
## Sodii Sulphas Effervescens.

**Effervescent Sodium Sulphate** is prepared by granulating a mixture of anhydrous sodium sulphate with sodium bicarbonate, and citric and tartaric acids. Compare Sodii Phosphas Effervescens.

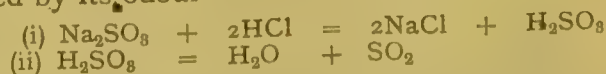
[Dose.—60 to 120 grains (repeated);  $\frac{1}{4}$  to  $\frac{1}{2}$  ounce (single).]

## Sodii Sulphis.

**Sodium Sulphite**,  $\text{Na}_2\text{SO}_3, 7\text{H}_2\text{O}$ , may be obtained by the action of sulphurous acid on a solution of sodium carbonate, thus—



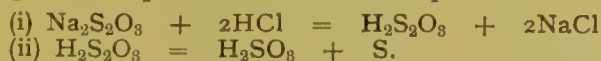
**Characters and Tests.**—Sodium sulphite occurs in efflorescent, inodorous, colourless monoclinic prisms, with a saline and sulphurous taste. It is freely soluble in water, only sparingly soluble in alcohol, and affords the reactions characteristic of sodium and of sulphites. The aqueous solution of pure normal sodium sulphite is slightly alkaline in reaction owing to the partial hydrolysis of the salt by water. If treated with hydrochloric acid, sulphurous acid is formed, and this partly decomposes into water and sulphurous anhydride, which is recognised by its odour—



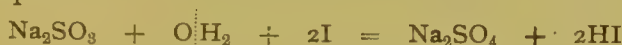
while the reaction mixture remains clear. A cloudiness or precipitate of sulphur



will be obtained if thiosulphate be present, because thiosulphuric acid is unstable and breaks up into sulphurous acid and sulphur—



Sodium sulphite is readily converted into sulphate by many oxidising agents and this behaviour forms the basis of the official volumetric determination. Each gramme of the salt, dissolved in 50 C.c. of water, should decolorise between 77.7 and 81.7 C.c. of decinormal iodine solution. According to the following equation, it will be seen that water forms the medium for the oxidation of the sulphide—



one molecular weight  $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$  (250.38) will therefore react with two atomic weights of iodine ( $125.9 \times 2$ ). The official volumetric solution of iodine is decinormal, and contains 12.59 grammes of iodine per litre.

∴ 250.38 grammes  $\text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O}$  are equivalent to 20,000 C.c. N/10 iodine solution.

$$\therefore 1 \text{ gramme } \text{Na}_2\text{SO}_3 \cdot 7\text{H}_2\text{O} = \frac{20,000}{250.38} \text{ C.c.} = 79.88 \text{ C.c.}$$

Since one gramme of the pure salt will decolorise 79.88 C.c. of iodine solution the higher limit allowed in the Pharmacopœia (81.7 C.c.) can only be reached by a partially effloresced salt. In conducting the titration the salt should be quickly dissolved in freshly boiled and cooled water, and the titration completed as quickly as possible in order to minimise the error due to conversion of sulphite to sulphate by the air, or the sulphite may be dropped into excess of iodine solution and titrated back with sodium thiosulphate.

**Notes.**—In photography, sodium sulphite is used as an addition to “developing” solutions, the oxidation of which by the air is retarded by the salt. It should be carefully stored, as by absorption of oxygen it becomes converted into sulphate, which is inoperative as a reducing agent.

[Dose.—5 to 20 grains.]

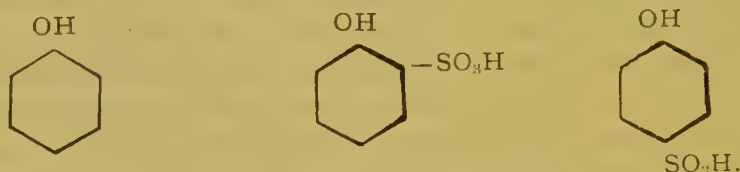
## Sodii Sulphocarbolas.

**Sodium Sulphocarbolate**,  $\text{C}_6\text{H}_4(\text{OH})\text{SO}_2\text{ONa} \cdot 2\text{H}_2\text{O}$ , is the sodium salt of phenol para-sulphonic acid. It is obtained by the action of sulphuric acid on phenol, under certain conditions, and conversion of the phenol-sulphonic acid, produced in that way, into its sodium salt. When phenol is dissolved in strong sulphuric acid a substitution product is obtained, phenol

sulphonic acid, which has the constitution  $\text{SO}_2 \begin{cases} \text{C}_6\text{H}_4(\text{OH}). \\ \text{OH} \end{cases}$  This is a di-substi-

tution product of benzene, and consequently can exist in the three isomeric forms known as the ortho-, meta-, and para- varieties, according to the relative position of the two substituting groups (in this case hydroxyl, OH, and the sulphonic group,  $\text{SO}_3\text{H}$ ) in the benzene nucleus. When a mono-derivative is thus converted into a di-derivative, the variety of the latter compound obtained depends mainly upon the nature of the substituting group already present in the mono-substitution derivative, and not upon the nature of the second substituting

radical. Although it is difficult to give in any simple manner the general laws which govern the course of the reaction in these cases, the following statement will enable the reader to grasp broadly the facts of the case. If the compound formed by adding hydrogen to the radical already present is readily oxidisable, then the second entering radical will take up the meta- position relatively to the first. This, therefore applies, for example, to nitro ( $\text{H} - \text{NO}_2$ ) carboxyl ( $\text{H} - \text{COOH}$ ) and sulphonic ( $\text{H} - \text{SO}_3\text{H}$ ) derivatives, since nitrous, formic, and sulphurous acids are all easily oxidisable substances. As a matter of fact, nitrobenzene,  $\text{C}_6\text{H}_5(\text{NO}_2)$ , benzoic acid,  $\text{C}_6\text{H}_5(\text{COOH})$ , and benzene sulphonic acid,  $\text{C}_6\text{H}_5(\text{SO}_3\text{H})$ , when converted into di-derivatives, form the meta- variety, no matter what the nature of the second substituting radical may be. On the other hand, if the compound obtained by adding hydrogen to the first radical is not easily oxidisable, then the second entering radical takes up the ortho- and the para- positions, although the para- compound usually predominates. For example, hydroxyl, chlorine, and amidogen derivatives yield ortho- and para-derivatives, because water ( $\text{H} - \text{OH}$ ), hydrochloric acid ( $\text{H} - \text{Cl}$ ), and ammonia ( $\text{H} - \text{NH}_2$ ) are bodies only oxidised with difficulty. In the case of phenol and sulphuric acid, ortho- and para-phenol sulphonic acids will consequently be obtained—

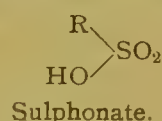
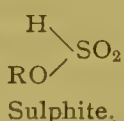
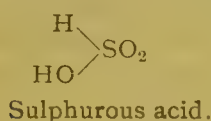


It must be remembered that this rule is only broadly true, as a small quantity of the variety contrary to the rule is obtained in most reactions. In order to obtain only the para-acid, the mixture of phenol with excess of sulphuric acid is maintained for some time at a temperature of  $100^\circ - 110^\circ \text{C}$ . The ortho-acid, which is simultaneously formed at ordinary temperatures by the first action between the phenol and sulphuric acid, is by this means converted into the para-variety, because at higher temperatures the ortho-acid which has been formed, splits up again in phenol and sulphuric acid, and the former is sulphonated again at  $100^\circ - 110^\circ \text{C}$ . almost entirely to the para- acid. The ortho-phenol-sulphonic acid (which has been used as an antiseptic under the name of "aseptol") is formed in preponderating quantity when the phenol reacts with sulphuric acid at low temperatures. The phenol sulphonic acids are separated from the excess of sulphuric acid by neutralisation with barium carbonate, barium sulphate being precipitated while the barium phenol-sulphonate is readily soluble. By adding sodium carbonate to the filtrate, barium carbonate is precipitated, while the sodium phenol-sulphonate, known commercially as sodium sulphocarbolate, remains in solution.

**Characters and Tests.**—Sodium sulphocarbolate occurs in colourless, transparent rhombic prisms, which are inodorous, or nearly so. Its taste is saline and somewhat bitter, and it is soluble in 6 parts of water, or 150 parts of 90 per cent. alcohol, the solutions being neutral to litmus. When ignited it evolves phenol and leaves a residue of sodium sulphate. It imparts a yellow

colour to flame, like all sodium salts. The dilute aqueous solution gives a violet coloration with ferric chloride, but is distinguished from salicylates by not giving a yellow-brown compound with uranium nitrate solution. The freshly prepared aqueous solution gives no immediate precipitate with barium chloride unless some sulphate be present, although on standing, the sulpho-carbolate is dissociated partly into phenol and sodium sulphate, and then gives the reaction with barium chloride.

**Notes.**—Sulphonates are isomeric with sulphites. In the former the radical is directly connected with the sulphur, while in sulphites it replaces the hydrogen in a hydroxyl group, as shown by the following general formulæ:—

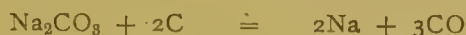


It is well to compare the difference between the behaviour of sulphites and sulphonates, noting the formation of the latter by oxidation of the thio-alcohols or mercaptans RSH, which is evidence of the direct connection between the sulphur and the radical.

[Dose.—5 to 15 grains.]

## Sodium.

**Sodium** is a metal which is so readily oxidised by the air, and by contact with bodies containing oxygen, that it should be preserved in well-stoppered bottles under mineral naphtha. The metal was discovered by Davy, who electrolysed fused sodium hydroxide. It was afterwards prepared on the manufacturing scale by heating a mixture of sodium carbonate and carbon, lime or chalk being added to prevent the sodium carbonate fusing and separating from the carbon—



This process was afterwards improved by Castner, who heated sodium hydroxide with iron carbide, the latter compound being obtained by heating iron scales with pitch. Six parts of hydroxide by this process yield 1 part of metal and 5 parts of carbonate, which corresponds nearly with the equation—



The advantage of this process over the former method is chiefly the lower temperature at which it may be carried out, but it, in turn, has been recently replaced by the electrolytic method founded on the process discovered by Davy. This has been rendered possible on the commercial scale by the greater facility and cheapness with which electricity is now produced, and is carried out by passing an electric current through fused sodium hydroxide heated only slightly above its melting point. Suitable mechanical arrangements are provided to keep the oxygen, which is given off at the anode, from coming into contact with the metallic sodium which rises to the surface of the molten hydroxide and is from time to time skimmed off.



**Characters and Tests.**—Sodium, as met with in commerce, is a soft metal, which is rapidly oxidised in air, but shows a bright, metallic surface when freshly cut. It attacks water violently, forming sodium hydroxide and liberating hydrogen—



and also 90 per cent. alcohol, the water present in this fluid being first attacked, little or no insoluble matter remaining when evolution of hydrogen ceases. It imparts an intense yellow colour to flame. Each gramme, very cautiously added to water, affords a solution of sodium hydroxide, which should require for neutralisation at least 42.6 C.c. of normal sulphuric acid solution.

**Notes.**—The quantitative determination of purity is best made in the following manner: Cut out with a sharp knife a cubical piece of the metal, so that it shall have a bright, metallic surface on all sides. After removing adherent naphtha rapidly by means of blotting paper, determine the weight of the selected portion without delay, in order to minimise the disturbing influence of the oxidation which occurs as soon as the metal is exposed to air. For the same reason it is better to find the weight of a selected piece rather than to attempt to take any predetermined weight of metal, the exact adjustment of which would necessarily occupy some time. The weighed portion is then cut into small pieces, which are added piece by piece to some water in a dish or beaker, allowing each piece to disappear before adding the next. The vessel is covered by a glass plate while the several pieces of sodium are reacting with the water, in order to avoid loss of solution by spurting. When the reaction is finally completed, the glass plate is rinsed with water, and the washings added to the contents of the beaker or dish. The weight of sodium taken may be between 0.5 and 1.0 gramme: this quantity added to about 70 C.c. of water, and the solution diluted to exactly 100 C.c., may be divided into two equal parts for titration. According to the equation—



22.88 grammes of pure sodium will produce sufficient sodium hydroxide to neutralise 48.67 grammes ( $\frac{1}{2}\text{H}_2\text{SO}_4$ ) of sulphuric acid.

$$\begin{array}{rcl} \therefore 22.88 \text{ grammes of sodium neutralise } & 1,000 \text{ C.c. N/1 H}_2\text{SO}_4 & \\ & 1,000 & \\ \text{and 1 gramme} & \text{,,} & \frac{\text{---}}{22.88} \text{ C.c. N/1 H}_2\text{SO}_4 \\ & & = 43.71 \text{ C.c.} \end{array}$$

The official requirement that 1 gramme of sodium shall neutralise 42.6 C.c. of N/1  $\text{H}_2\text{SO}_4$  corresponds, therefore, to a purity of not less than 97.46 per cent.

## Spiritus.

**Spirits.**—The group of official “spirits” comprises solutions of substances in strong alcohol. For the purposes of systematic study they may be broadly divided into two classes:—(1) Simple alcoholic solutions of various bodies, chiefly volatile oils, in various proportions. (2) Compound alcoholic solutions of various substances whose preparation involves more complicated processes than simple mixture.

**Class I.—Simple Alcoholic Solutions** in 90 per cent. alcohol. This class contains the following eleven members:—

Spiritus.	SPIRIT OF	PROPORTION OF MEDICAMENT BY VOLUME	DOSE, IN MINIMS
<b>Ætheris</b>	ETHER	1 in 3	{ 20 to 40 (repeated) 60 to 90 (single)
<b>Anisi (oil)</b>	ANISE	1 „ 10	5 to 20
<b>Cajuputi (oil)</b>	CAJUPUT	1 „ 10	5 to 20
<b>Camphoræ</b>	CAMPHOR	1 „ 10	5 to 20
<b>Chloroformi</b>	CHLOROFORM	1 „ 20	{ 5 to 20 (repeated) 30 to 40 (single)
<b>Cinnamomi (oil)</b>	CINNAMON	1 „ 10	5 to 20
<b>Juniperi (oil)</b>	JUNIPER	1 „ 20	20 to 60
<b>Lavandulæ (oil)</b>	LAVENDER	1 „ 10	5 to 20
<b>Menthæ Piperitæ (oil)</b>	PEPPERMINT	1 „ 10	5 to 20
<b>Myristicæ (oil)</b>	NUTMEG	1 „ 10	5 to 20
<b>Rosmarini (oil)</b>	ROSEMARY	1 „ 10	

It will be observed that the spirits prepared from volatile oils contain 1 part in 10, with the exception of spirit of juniper. This is because oil of juniper varies in composition when obtained from berries grown in different regions, and does not usually give a clear solution with 10 volumes of 90 per cent. alcohol, and it becomes less soluble on keeping. Oils of juniper and nutmeg sometimes contain small proportions of constituents which are insoluble in the proportion of alcohol directed to be employed: in that case filtration is resorted to, a little talc being added to mechanically retain the insoluble oily matter. The active constituents in all these spirits are substances sparingly soluble in water: hence they form cloudy precipitates when poured into aqueous fluids, the diffusion of the precipitated body being much finer and more complete than one could obtain without the assistance of the alcohol. This furnishes the explanation for the employment of the spirits in place of the undiluted oil. If the proportion of water into which the “spirit” is poured be sufficiently large a clear solution may be obtained almost immediately, owing to the extended surface exposed to the solvent action of the water. In this way the “spirits” may be employed for the rapid production of a saturated aqueous solution of the sparingly soluble constituent, the method being officially adopted in principle for the production of camphor water.

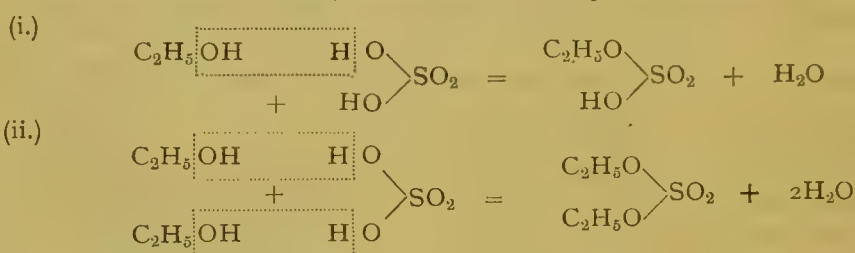
**Class II.—Compound Alcoholic Solutions.**—There are six official “spirits” belonging to this class—

<b>Spiritus Ætheris Compositus.</b>	<b>Spiritus Ammoniaë Fetidus.</b>
„ <b>Ætheris Nitrosi.</b>	„ <b>Armoraciæ Compositus.</b>
„ <b>Ammoniaë Aromaticus.</b>	„ <b>Vini Gallici.</b>

They do not admit of any simple method of classification and will, therefore, be considered in separate monographs.

## Spiritus Ætheris Compositus.

**Compound Spirit of Ether** is a modification of an old preparation known as Hoffmann's Anodyne, and is obtained by adding an ethereal fluid composed of a mixture of ether and ethyl sulphates (obtained by a special method of preparation) to a mixture of alcohol and ether. The ethereal fluid referred to above is prepared by mixing nearly equal volumes of 90 per cent. alcohol and sulphuric acid, the mixture being set aside for twenty-four hours, to allow the formation of ethyl esters of sulphuric acid to proceed. There are two of these, mono- and di-ethyl sulphate:—



The fluid is then distilled slowly, the temperature of the liquid in the still rising gradually. Distillation is stopped when a thermometer dipping in the fluid (not the vapour) indicates a temperature of  $172^\circ \text{C}$ . The reactions which ensue during this process are complicated, and result in the production of some ordinary ether, ethylene, and other substances in addition to ethyl sulphate. The fluid also blackens owing to the carbonisation of some of the alcohol, and a portion of the sulphuric acid is reduced thereby to sulphurous acid. The distillate is, therefore, complex, and contains in addition to the products already mentioned some alcohol and water. It separates into two layers, the upper ethereal one containing ethyl sulphate, and a lower aqueous layer which contains sulphurous acid. The latter is separated and rejected, while the ethereal layer is washed with a little water, and the mixture agitated with bicarbonate of sodium to neutralise adherent acid. The washed ethereal layer is then separated and added to a mixture of alcohol and ether. Sodium bicarbonate is employed in preference to the hydroxide which more rapidly decomposes the esters present.

**Characters and Tests.**—Compound spirit of ether is a colourless, mobile liquid, with a characteristic ethereal odour and taste. Specific gravity, 0.808 to 0.812. It gives an opalescent solution when diluted with twice its volume of water, owing to the precipitation of the ethyl sulphate, which is only sparingly soluble in water. On evaporating 2 or 3 C.c. spontaneously on a watch-glass, there should be no residue with an unpleasant odour, thus showing that the ethereal distillate has been washed and neutralised in the manner described.

**Notes.**—The official process for compound spirit of ether differs in various respects from the original process for Hoffmann's Anodyne, the modifications having been introduced with the object of rendering the production of the preparation less wasteful and uncertain, but it is still somewhat indefinite in composition. [*Dose.*—20 to 40 minims (repeated); 60 to 90 minims (single).

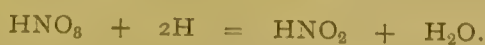


## Spiritus Ætheris Nitrosi.

**Spirit of Nitrous Ether** or **Sweet Spirit of Nitre** is an alcoholic solution containing ethyl nitrite aldehyde, and small quantities of other substances resulting from secondary reactions during the process of manufacture, or formed by decomposition of its constituents after preparation. It is prepared by mixing 20 volumes of 90 per cent. alcohol with 2 volumes of sulphuric and 3 volumes of nitric acid, and distilling the mixture from a retort containing copper turnings or foil. The temperature of the fluid, indicated by a thermometer immersed in it, should be maintained between  $77^{\circ}$  C. and  $79.4^{\circ}$  C.; if allowed to rise above  $80^{\circ}$  C., the reaction becomes too violent. A further portion of nitric acid may be added when the distillation is partly completed. The distillate is collected in a receiver containing alcohol, kept cool by means of ice, because the most valuable product of the reaction, ethyl nitrite, has a low boiling point, and would otherwise largely escape condensation. Distillation is stopped when the required volume of distillate is obtained, and this is then diluted with some more alcohol, assayed for ethyl nitrite, and finally diluted in accordance with the result of this essay, so that the product shall contain not less than 2.5 per cent. of ethyl nitrite. If alcohol be heated with nitric acid alone some of the alcohol is oxidised to aldehyde by the nitric acid, the latter being reduced to *nitrous* acid. The nitrous acid reacts with more ethyl alcohol to form ethyl nitrite. The distillate obtained in this way and containing chiefly aldehyde and ethyl nitrite dissolved in unchanged alcohol constituted the original sweet spirit of nitre, the nitric acid being at one time formed in the process from potassium nitrate and sulphuric acid. The process in the present Pharmacopœia directs the addition of copper, with the intention of reducing the nitric acid to nitrous acid, and so increasing the yield of ethyl nitrite. The nitric acid is added in two portions, so as to moderate the rate of reaction. The exact part played by the copper may be interpreted in several ways. Note, however, that the residue after distillation contains excess of metallic copper with blue crystals of copper sulphate. Probably, however, copper nitrate is first formed, since sulphuric acid of the strength employed has no action on copper. Copper nitrate being first formed would, however, be decomposed by sulphuric acid with regeneration of nitric acid and production of copper sulphate. It is obvious that in the formation of copper nitrate the hydrogen of the acid is displaced by copper—



This hydrogen never appears as the free elementary gas, but reduces some more of the nitric to nitrous acid.



The nitrous acid then reacts with alcohol to form ethyl nitrite and water—



while the copper nitrate is acted upon by the sulphuric acid—

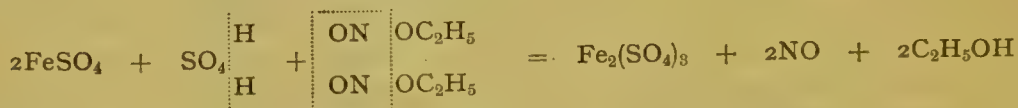


Adding these four equations together we get the form in which the initial and final conditions of the reacting substances are usually represented—



This equation only represents the formation of ethyl nitrite, which, however, is the most valuable constituent of the product. Numerous other reactions occur, which are of subsidiary importance. Spirit of nitrous ether should be stored in a cool, dark place, in well-closed vessels, which should be of such a size that the contents may be quickly used up after the vessel is once opened.

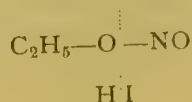
**Characters and Tests.**—Spirit of nitrous ether is a limpid, faintly yellow, inflammable fluid, with a fruity and apple-like odour, and a characteristic warm taste. Specific gravity 0.838 to 0.842. When poured carefully on the surface of a strong solution of ferrous sulphate acidulated with sulphuric acid and contained in a test-tube, a deep olive-brown coloration is produced where the two layers of liquid are in contact. This is the usual test for nitrates or nitrites, and the coloration is due to a compound of nitric oxide with the ferrous sulphate, the nitric oxide being produced by the reduction, in this case, of the ethyl nitrite by means of the ferrous sulphate. A portion of the ferrous sulphate becomes thereby ferric sulphate, another portion of the ferrous sulphate uniting with the nitric oxide to produce the dark brown substance.



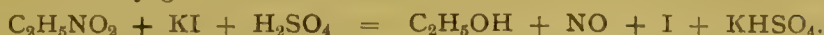
10 C.c. of the spirit, mixed with 5 C.c. N/1 sodium hydroxide solution and 5 C.c. of water, should assume a yellow colour, which should not become brown on standing 12 hours. This test, for the limit of aldehyde, is based upon the polymerisation of aldehyde under the influence of the sodium hydroxide. The polymer so produced is a brown substance of unknown, but probably high, molecular weight, and from its appearance is sometimes called aldehyde resin. Spirit of nitrous ether should not effervesce, or only feebly, when shaken with sodium bicarbonate, showing absence, or presence of only traces, of free acid. More than traces of free acid will be present if the spirit has been carelessly prepared or prepared by some process other than the official one. Old samples may also become acid through oxidation of the aldehyde to acetic acid or hydrolysis of the ethyl nitrite with formation of nitrous acid—



The proportion of ethyl nitrite present is determined by measuring the volume of nitric oxide obtained when potassium iodide and dilute sulphuric acid are added to a known volume of the spirit. Those two reagents practically yield hydriodic acid, which is very commonly used as a reducing agent in organic chemistry. In the present instance ethyl nitrite, which is an ester of nitrous acid and consequently a derivative of nitrous anhydride (nitrogen trioxide),  $\text{N}_2\text{O}_3$ , yields the lower oxide, NO.



The equation usually given is—



From this it is evident that 74.52 grammes of ethyl nitrite (molecular weight  $\text{C}_2\text{H}_5\text{NO}_2 = 74.52$ ) will yield 29.82 grammes of nitric oxide (molecular weight  $\text{NO} = 29.82$ ), but we know that 29.82 grammes of nitric oxide measure 22.32 litres at  $0^\circ \text{C}$ . and 760 Mm. pressure, because 2 grammes of hydrogen under the same conditions measure this volume, and nitric oxide is 14.91 times heavier than hydrogen. Hence 22.32 litres of nitric oxide, or 22,320 C.c., will be obtained from 74.52 grammes of ethyl nitrite, from which it follows that each C.c. of nitric oxide evolved indicates  $\frac{74.52}{22320}$  gramme of ethyl nitrite in

the spirit of nitrous ether taken for analysis. The maximum B.P. requirements are that the spirit shall yield seven times its volume of nitric oxide at  $15.5^\circ \text{C}$ . and 760 Mm. pressure. If, therefore, 5 C.c. of spirit be taken, one ought to obtain 35 C.c. nitric oxide under the conditions mentioned. To find the percentage of ethyl nitrite if this volume of gas be obtained proceed as follows—

35 C.c. nitric oxide at  $15.5^\circ \text{C}$ . will measure

$$\frac{35 \times 273}{273 + 15.5} = 33.1 \text{ C.c. at } 0^\circ \text{C}.$$

$$\text{Now } 22320 \text{ C.c. NO} = 74.52 \text{ grammes } \text{C}_2\text{H}_5\text{NO}_2$$

$$\therefore 1 \text{ C.c. NO} = \frac{74.52}{22320} \quad \text{''} \quad \text{''}$$

$$\therefore 33.1 \text{ C.c. NO} = \frac{74.52 \times 33.1}{22320} \quad \text{''} \quad \text{''}$$

$$= 0.1105 \quad \text{''} \quad \text{''}$$

Therefore the 5 C.c. of spirit of nitrous ether contains 0.1105 gramme of ethyl nitrite. Taking the specific gravity of the spirit as 0.840, the mean of the official limits, 5 C.c. will weigh  $0.840 \times 5 = 4.20$  grammes.

Now 4.2 grammes of spirit of nitrous ether contain 0.1105 gramme  $\text{C}_2\text{H}_5\text{NO}_2$

$$\therefore 1 \quad \text{''} \quad \text{''} \quad \text{''} \quad \text{''} \quad \frac{0.1105}{4.2} \quad \text{''} \quad \text{C}_2\text{H}_5\text{NO}_2$$

$$\therefore 100 \quad \text{''} \quad \text{''} \quad \text{''} \quad \text{''} \quad \frac{0.1105 \times 100}{4.2} \quad \text{''} \quad \text{C}_2\text{H}_5\text{NO}_2$$

$$= 2.63 \text{ per cent.}$$

Even after it has been kept some time and the bottle occasionally opened, it should yield not much less than 5 times its volume of nitric oxide, corresponding to nearly 2 per cent. of ethyl nitrite, or a minimum of 1.75 per cent.

**Notes.**—Exposure to direct sunlight causes some decomposition to take place in spirit of nitrous ether, but no chemical action appears to be induced by diffused light, however bright, and perfect protection against change is afforded by the use of amber-coloured glass bottles to contain the spirit. The deterioration which takes place when the spirit is not kept under proper conditions is partly due to the escape of ethyl nitrite, for the boiling point of ethyl nitrite is so low ( $17^\circ \text{C}$ .) that it readily escapes, even at ordinary temperatures, from the alcohol in which it is dissolved. Ethyl nitrite also readily undergoes hydrolysis by contact with water, ethyl alcohol and nitrous acid being formed. This reaction proceeds slowly in the spirit of nitrous ether, since only 10 per cent.



of water is present, but takes place rapidly when the spirit is diluted with water as in "mixtures" having an aqueous vehicle. For this reason it would probably be more advantageous to prescribe the preparation in such a way that it should be only mixed with water at the time of administration. The isomerism of the nitrites with the nitro-derivatives of the hydro-carbons should be noted, the empirical formula for both being  $R-NO_2$  where R stands for any organic radical. They are distinguished by their behaviour towards hydrolytic and reducing agents. In the case of nitro-compounds hydrolysis is not effected, and an amine  $R-NH_2$  is obtained by treatment with nascent hydrogen. For these reasons the nitrogen is considered to be linked directly to the carbon of the radical, and the formula assigned to the nitro-compounds is consequently

$R-N \begin{smallmatrix} \diagup O \\ \diagdown O \end{smallmatrix}$  In the case of nitrites, under similar circumstances, hydrolysis is

easily effected with formation of an alcohol  $R-OH$ , and nitrous acid or a salt thereof, while reducing agents also produce an alcohol and ammonia or hydroxylamine. In these reactions the nitrogen is removed from the hydrocarbon radical, and the formula assigned to nitrites is  $R-O-NO$ , which shows that the nitrogen is linked to the radical, not directly, but through oxygen.

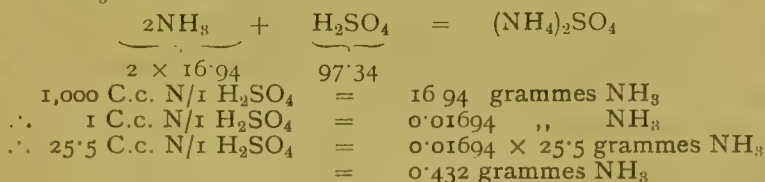
[Dose.—20 to 40 minims (repeated); 60 to 90 minims (single).]

## Spiritus Ammoniæ Aromaticus.

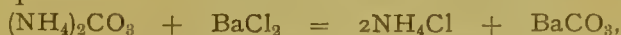
**Aromatic Spirit of Ammonia**, or "spirit of sal volatile," is an alcoholic solution of ammonia and ammonium carbonate, flavoured with a small proportion of the oils of nutmeg and lemon. The oils are dissolved in a mixture of 90 per cent. alcohol (2 parts) and water (1 part), and the liquid subjected to distillation. The last fraction of the distillate, which will be almost entirely water, is collected separately and used for the solution of the ammonium carbonate because this salt is only slightly soluble in strong alcohol. This aqueous fraction is placed in a strong bottle with the ammonium carbonate and strong solution of ammonia, securely corked to avoid loss of ammonia and tied down so that the cork may not be expelled by the pressure of the ammonia gas within. The bottle is then immersed in warm water at 60° C. (to accelerate solution) and agitated occasionally until solution is effected. The solution is quickly filtered through cotton wool and added gradually to the distilled alcoholic liquid, with constant stirring, so that the ammonium carbonate may be quickly diffused. The preliminary distillation of the oils with alcohol probably blends and improves the flavour of the product. It also excludes some constituent of the oil of nutmeg which is left behind in the still, and the presence of which in the spirit leads to rapid darkening on the addition of the ammonia. Similar darkening may also be caused by the action of ammonia on oil of lemon, or on the furfural present in alcohol of inferior quality.

**Characters and Tests.**—Aromatic spirit of ammonia is a transparent liquid, having a pungent ammoniacal odour and flavour. It is nearly colourless when first prepared, but is liable to darken slightly, that tendency being more marked if the preparation has been made by solution of the oils without distilla-

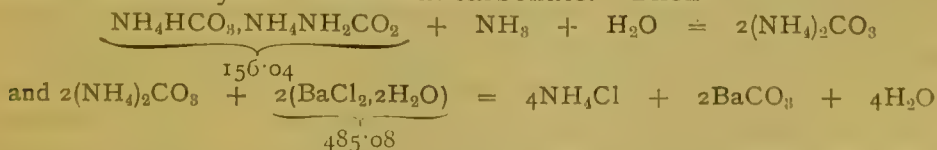
tion, as directed in the Pharmacopœia. Specific gravity, 0·888 to 0·893. The total alkalinity of the spirit may be determined by titration with sulphuric acid, using methyl-orange as indicator, since this is not effected by the carbonic acid liberated from the ammonium carbonate. Twenty C.c. of the spirit should require for neutralisation 25·5 C.c. of normal sulphuric acid solution corresponding to about 2·4 per cent. of ammonia gas (as free ammonia and carbonate) or 2·16 grammes  $\text{NH}_3$  in 100 C.c.



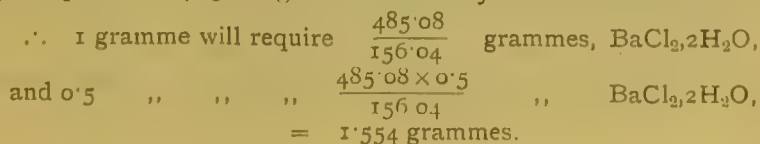
and 0·432 grammes  $\text{NH}_3$  in 20 C.c. of the aromatic spirit =  $0\cdot432 \times 5 = 2\cdot16$  grammes in 100 C.c. Taking the specific gravity as 0·8905, *i.e.*, the mean of the official limits, 100 C.c. of the spirit will weigh 89·05 grammes, and 2·16 grammes of  $\text{NH}_3$  in 89·05 grammes of the spirit is equivalent to 2·425 per cent. Since the titration with sulphuric acid only yields an indication of total alkalinity a further test is required to show that a due proportion of ammonia is present as carbonate. The Pharmacopœia directs that “20 C.c., after the addition of 16 C.c. of solution of barium chloride (each C.c. of which contains 0·1 gramme  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ , *vide* B.P. Appendix, p. 405) should yield a precipitate which becomes more copious on heating to  $71^\circ \text{C}$ ., and, after filtering, the filtrate should yield a further precipitate, when more of the reagent is added and the liquid is again heated.” This test is based upon the assumption that the quantity of barium chloride solution, 16 C.c., contains rather less than sufficient barium chloride to precipitate the ammonium carbonate present according to the equation—



so that after filtration the filtrate will still contain sufficient ammonium carbonate to give a further precipitate of barium carbonate on the addition of barium chloride solution. The metric quantities given in the official formula for the preparation of the spirit will yield very nearly 4,000 C.c. Therefore, assuming that no loss of ammonium carbonate has taken place during manufacture, the 20 C.c. taken for analysis should contain 0·5 gramme of the official salt. Let us assume that this is composed of carbamate and acid carbonate in equimolecular proportions, which by solution in presence of excess of ammonia yield the normal carbonate. Then—



From this it follows that the normal ammonium carbonate will require for complete precipitation 485·08 grammes of crystallised barium chloride.



The quantity of barium chloride solution to be used for the official test is 16 C.c. Since each C.c. of this solution contains 0.1 gramme (*vide* B.P. Appendix, p. 405) the 16 C.c. will contain 1.6 gramme  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ , *i.e.*, a quantity actually in excess of that required by the ammonium carbonate present. The test has, moreover, been shown to be fallacious from other causes (see *Pharm. Journ.* [4], 10, p. 144), because the precipitation of the carbonate is only complete if considerable excess of barium chloride be present. Addition of ammonium chloride is said to render the indications more definite.

**Notes.**—The details of the test for carbonate should be noted. In the usual scheme for qualitative analysis the metals of the barium group (Ba, Sr, Ca) are precipitated as carbonates. The complete precipitation of these carbonates takes some time in the cold. It is, however, hastened by warming, but the precipitation mixture should not be boiled, otherwise the reaction will be partially reversed, and a portion of the precipitated carbonate go into solution again as chloride. [*Dose.*—20 to 40 minims (repeated); 60 to 90 minims (single).]

## Spiritus Ammoniae Fetidus.

**Fetid Spirit of Ammonia.**—In preparing this, a tincture of asafetida is first made by macerating the drug in 90 per cent. alcohol. The tincture is then distilled, the alcoholic distillate mixed with strong solution of ammonia, and its volume adjusted by the addition of sufficient 90 per cent. alcohol to yield the required bulk.

**Tests.**—Fetid spirit of ammonia should contain at least 2.88 grammes of ammonia in 100 C.c., if prepared with the proper proportion of solution of ammonia, 25 C.c. of the spirit, neutralising at least 42.5 C.c. of normal sulphuric acid solution, thus—

$$\begin{aligned} 100 \text{ C.c. of the spirit will neutralise } 170 \text{ C.c. N/1 H}_2\text{SO}_4, \\ \text{and } 1 \text{ C.c. N/1 H}_2\text{SO}_4 &= 0.01694 \text{ grammes NH}_3 \\ \therefore 170 \text{ C.c. N/1 H}_2\text{SO}_4 &= 0.01694 \times 170 \text{ grammes} = 2.88 \text{ grammes NH}_3 \end{aligned}$$

**Notes.**—The finished preparation should be nearly colourless, and contains the volatile oil of asafetida, which distils over with the alcohol, while the other constituents are left in the still.

[*Dose.*—20 to 40 minims (repeated); 60 to 90 minims (single).]

## Spiritus Armoraciae Compositus.

**Compound Spirit of Horseradish** is prepared by mixing fresh-scraped horseradish root, bruised bitter-orange peel, and nutmegs with water (6 parts), and 90 per cent. alcohol (5 parts). The pungent odour of horseradish appears to be due to the development of an oil composed chiefly of allyl isothiocyanate (like mustard oil) by the decomposition of a glucoside closely resembling, if not identical with, the sinigrin of mustard. The decomposition is also effected in an analogous manner, *viz.*, by the action of an unorganised ferment, the two substances being brought into contact by the scraping and consequent rupture of the cells in which they are contained. When the mixture with alcohol and water is distilled the alcoholic distillate comes over impregnated with this oil and the aromatic constituents of the orange peel and nutmegs. Since alcohol has a coagulating and, therefore, inhibitory action upon



ferments, the development of oil from the horseradish, and consequently the potency of the preparation, might possibly be increased by a preliminary soaking of the scraped horseradish in the water alone. [Dose.—1 to 2 fluid drachms.

## Spiritus Rectificatus.

**Alcohol** (90 per cent.) or **Rectified Spirit** contains 90 parts by volume of ethyl alcohol or hydroxide,  $C_2H_5OH$ , and 10 parts by volume of water. It is obtained by the distillation of fermented saccharine liquids. The production of alcohol by fermentation is conducted in various ways in different parts of the world, although the principle remains the same, viz., the action of yeast upon sugar solutions and separation of alcohol from the fermented liquid by fractional distillation. The sugar solution for fermentation is prepared, for example, in England chiefly from the starch of grain, in Germany from potato starch, in France from beet sugar, in America from maize, and in India and the East from rice. The spirit prepared from grain is preferred to that from potatoes, since it is usually more wholesome, being freer from unpleasant and noxious substances which are always formed by secondary reactions during fermentation. Starch is not directly fermentable, but must first be converted into certain varieties of sugar. In the preparation of grain spirit barley is first malted, *i.e.*, is moistened and maintained at a temperature which induces the grain to sprout or germinate. During this process of germination there is formed in the embryo an unorganised ferment, known as diastase, whose function, under natural conditions of life, is to convert the insoluble starch in the endosperm of the grain into a soluble form of sugar, which is utilised during the growth and development of the seedling. When the germination has proceeded to the desired extent the grain is dried at a temperature sufficiently low not to destroy the diastase, while the removal of the water checks any further development of the embryo. The product constitutes malt, and contains sufficient diastase to convert into sugar the starch of a considerable quantity of unmalted grain, in addition to its own starch which remains unconverted at the time when germination is stopped by drying. Hence there is no necessity to malt the whole of the grain, and a mixture of malted and unmalted grain is mashed and digested with water at a temperature about, but not much exceeding,  $60^{\circ}C$ . At this temperature the diastase exhibits its maximum activity, and quickly converts the starch into a soluble sugar called maltose and dextrin, the latter being isomeric with starch. Dextrin, like starch, is not directly fermentable; it is, however, soluble in water, and appears to pass into fermentable sugar during the fermentation of the saccharine fluid. The conversion of the starch into maltose is really a case of hydrolysis, the complex starch molecule taking up water, and yielding substances of smaller molecular weight. It should be observed that, although the empirical formula for starch is  $C_6H_{10}O_5$ , its molecular formula is some multiple of this. The molecular weight of starch is at present unknown, because none of our methods of molecular weight determination can be applied to it, for starch cannot be vaporised or dissolved in any solvent

without undergoing chemical alteration. For this reason the formula is sometimes expressed as  $(C_6H_{10}O_5)_n$ , the value of " $n$ " being at present undetermined. When the conversion of the starch of the grain-mash into sugar and dextrin is completed, the mash is cooled to about  $15^\circ$  C., and a sufficient quantity of yeast added. Fermentation then sets in, accompanied by multiplication of the yeast cells and evolution of carbon dioxide and considerable heat. During this process the sugar disappears, and is converted by the activity of the yeast into alcohol, which remains in the fluid, and carbon dioxide. In the case of the glucoses this appears to be expressed by the equation—



while in the case of maltose, a molecule of water takes part in the reaction—



The exact mode by which the yeast produces its fermentative effects is unknown. It has been suggested that the sugar is taken up by the yeast cells, and that the substances found in the fermented fluid are excretory products formed by the metabolic changes in the yeast protoplasm. Fermentation has been observed, however, with a yeast extract containing no yeast cells. The production of heat during fermentation is accounted for by the fact that the heat of combustion of the alcohol is less than that of the sugar from which it is derived. Although the equations given above broadly express the nature of the changes induced by the fermentative action of yeast, as a matter of experience it is found that only about 95 per cent. of the sugar is converted into alcohol, the remainder appearing in the form of glycerin, succinic acid, various homologues of ethyl alcohol (which together constitute the product known as fusel-oil), and traces of other bodies. Apart from the theoretical considerations concerned, certain points of practical importance must now be considered. Thus, in the fermenting fluid the action of the yeast ceases when the proportion of alcohol present reaches about 14 per cent., owing to the inhibitory effect of the alcohol upon the yeast. The sugar-strength of the saccharine fluid is therefore adjusted so that the sugar shall be all used up before this proportion of alcohol is reached; otherwise that which remains is wasted. The temperature of the fermenting fluid is also kept, by suitable cooling arrangements, below  $30^\circ$  to  $33^\circ$  C. for two reasons; firstly, the yeast exerts its maximum activity below this temperature, and, secondly, a higher temperature encourages the activity of other fermentative organisms, *e.g.*, the bacilli of lactic and butyric acid fermentations, which are most active at temperatures above  $30^\circ$  C. Since those organisms are found everywhere and can hardly, under manufacturing conditions, be entirely excluded from the fermenting liquor, it is desirable to limit their activity as far as possible, because they convert the sugar into substances other than alcohol, and thus introduce foreign substances into the liquid, from which the alcohol must afterwards be purified. Yeast, like all other living organisms, requires certain substances, *viz.*, inorganic salts and nitrogen in the form of ammonia or proteid substances, for its growth and development. The actual amount of such substances required is, however, small, and sufficient of them is

always present in the fermenting fluid derived from the water used, or the saccharine materials employed. When fermentation of the mash is complete, as shown by the slackening in the evolution of the carbon dioxide, it is subjected to distillation. In some breweries and distilleries, by carrying on the fermentation in vats of suitable construction, the carbon dioxide is collected and liquefied by pressure. The liquefied gas, preserved in steel tubes, is utilised for various purposes, *e.g.*, the production of aerated waters. The distillation of the fermented mash is conducted slowly in an apparatus arranged on the principle of fractional distillation. The vapours arising from the still do not pass immediately to the condenser, several chambers being interposed in which the vapours are partially condensed. Since the boiling point of alcohol is lower than that of water the latter is condensed in greater proportion than alcohol in these intermediate chambers, and the vapour which ultimately reaches the condenser, and is there liquefied, often contains 90 per cent. of alcohol, the remaining 10 per cent. being water and small quantities of those substances already mentioned as being produced in addition to alcohol during fermentation. The distillate of raw spirit is not fit for use as a beverage or medicine on account of the disagreeable and noxious impurities which it contains. It is usually diluted with water, which causes the separation of oily impurities insoluble in the diluted alcohol, and filtered through charcoal. The filtrate is then again fractionally distilled, the first runnings, containing aldehyde, being separated. The middle portions constitute rectified spirit, whilst the last portions, or "tailings," contain considerable quantities of the higher homologues of ethyl alcohol. Those homologues, which constitute "fusel oil," have boiling points higher than that of ethyl alcohol. When potatoes are employed they are first steamed, in order to soften them and break down the starch grains. After cooling, they are mashed with the required proportion of malt, and the mash treated in the manner already described. The residues obtained in the manufacture of beet sugar also contain quantities of sugar which cannot be separated economically as refined sugar, and are therefore submitted to fermentation to produce alcohol. Fractional distillation alone is not capable of eliminating the whole of the water from alcohol, and, commercially, it is usually applied to the extent of obtaining a distillate containing 90 to 95 per cent. of alcohol. The remaining 5 to 10 per cent. of water may be abstracted by the addition of substances which combine with the water, such as quicklime, anhydrous calcium chloride, etc. Redistillation then yields a distillate containing something less than 1 per cent. of water, which constitutes the "Alcohol Absolutum" of the Pharmacopœia. The removal of the last traces of water may be effected by the addition of a small quantity of metallic sodium which reacts with the water to form sodium hydroxide. If excess of the metal be present, sodium ethylate will be formed, and, in any case, it is exceedingly difficult to obtain a distillate absolutely free from water, since ethyl alcohol readily absorbs traces of moisture from the air.

**Characters and Tests.**—Rectified spirit is officially described as a colourless, transparent, mobile, and inflammable liquid. It contains 90 per



cent. by volume of real alcohol, and has a specific gravity of 0·8340. That corresponds to 85·65 per cent. by weight of real alcohol, since 100 C.c. of rectified spirit (s.g. 0·834) weighs 83·4 grammes, and contains 90 C.c. of real alcohol (s.g., at 15·5°, 0·79381), weighing  $90 \times 0·79381 = 71·4429$  grammes. That weight of real alcohol in 83·4 grammes of rectified spirit equals  $71·4429 \times 100 \div 83·4$  per cent. = 85·65 per cent. Rectified spirit should burn with a blue, smokeless flame, and should leave no residue on evaporation. It remains clear when mixed with water in any proportion; any milkiness would be due to oily or resinous impurities incompletely separated by rectification or imparted to the spirit by careless storage, in uncleansed vessels, etc. Impurities due to inefficient rectification may also be detected by moistening a piece of white filter paper with the spirit and allowing it to evaporate; no unpleasant odour should be observed when the alcohol is entirely volatilised. This test depends upon the fact that most of the impurities (*e.g.*, amyl alcohol) have a higher boiling point than ethyl alcohol; the latter, consequently, evaporates more quickly than the impurities, the odour of which becomes perceptible on the filter paper when it is no longer covered by that of the alcohol. 100 C.c. of the spirit, with 2 C.c. of N/10 silver nitrate solution, exposed to bright light for twenty-four hours, and then decanted from the black powder (reduced metallic silver) which has formed, undergo no further change when again exposed to light with more of the silver nitrate solution. This test shows the absence of more than traces of various organic substances, such as aldehyde, which have a reducing action upon silver nitrate. When mixed with half its volume of solution of potassium hydroxide good spirit will not immediately darken in colour, unless it contains more than traces of aldehyde, which is polymerised by contact with potassium hydroxide forming the yellowish-brown aldehyde-resin. Addition of solution of ammonia should not cause an immediate darkening in colour unless excessive proportions of aldehyde be present; or occasionally tannic acid may be extracted from the casks in which it is stored and then in the alkaline liquid blackish-brown oxidation products will be formed. The 90 per cent. alcohol of the present Pharmacopœia is slightly stronger than the Spiritus Rectificatus, B.P., 1885, containing 1·35 per cent. more ethyl hydroxide by volume, or 1·65 per cent. more by weight. On mixing strong alcohol with water, contraction of volume and rise of temperature occur. When such a mixture is prescribed in the Pharmacopœia the cooled liquid should be employed.

DILUTED ALCOHOL.					90 per cent. alcohol, parts by measure.	Water, parts by measure
Alcohol, 70 per cent., specific gravity 0·8900	...				100	31·05
" 60 "	"	"	0·9135	...	100	53·65
" 45 "	"	"	0·9436	...	100	105·34
" 20 "	"	"	0·9760	...	100	355·8

**Notes.**—On mixing strong alcohol with water minute bubbles of gas often form in the liquid, giving it a milky appearance. That effect, however, is only temporary, since the gas soon rises to the surface, and the milky appearance

should not be mistaken for the turbidity due to oil or resin referred to in the official tests. The evolution of the gas is due to the fact that air is more soluble in alcohol than in water, and is therefore partly expelled on dilution with the latter. The following table shows the apparent specific gravities of the official diluted alcohols at different temperatures:—

Degrees C.	90 per cent.	70 per cent.	60 per cent.	45 per cent.	20 per cent.
2	0·8454	0·9010	0·9242	0·9529	0·9795
3	0·8446	0·9002	0·9234	0·9522	0·9793
4	0·8438	0·8994	0·9226	0·9515	0·9790
5	0·8429	0·8986	0·9218	0·9508	0·9787
6	0·8421	0·8977	0·9210	0·9502	0·9785
7	0·8412	0·8969	0·9203	0·9495	0·9782
8	0·8404	0·8961	0·9195	0·9488	0·9780
9	0·8395	0·8953	0·9187	0·9481	0·9777
10	0·8387	0·8946	0·9179	0·9474	0·9774
11	0·8378	0·8936	0·9171	0·9468	0·9772
12	0·8370	0·8928	0·9164	0·9461	0·9769
13	0·8361	0·8920	0·9156	0·9454	0·9767
14	0·8353	0·8912	0·9148	0·9447	0·9764
15	0·8344	0·8904	0·9140	0·9440	0·9761
15·5	0·8340	0·8900	0·9135	0·9436	0·9760
16	0·8335	0·8895	0·9132	0·9433	0·9759
17	0·8327	0·8887	0·9124	0·9426	0·9756
18	0·8318	0·8879	0·9116	0·9419	0·9754
19	0·8310	0·8871	0·9108	0·9412	0·9751
20	0·8301	0·8863	0·9100	0·9405	0·9748
21	0·8293	0·8854	0·9093	0·9399	0·9746
22	0·8284	0·8846	0·9086	0·9392	0·9743
23	0·8276	0·8838	0·9078	0·9385	0·9741
24	0·8268	0·8830	0·9070	0·9378	0·9738
25	0·8259	0·8822	0·9062	0·9371	0·9735

The next table shows the proportions of 90 per cent. alcohol and water, at 15·5° C., required to produce 1 litre of any of the official diluted alcohols:—

Menstrua, B.P. 1898. Per cent. by volume.	Per cent. Absolute Alcohol by weight.	BY VOLUME.		BY WEIGHT.		Product, Specific Gravity, and Proof Strength at 15°·5 C.		
		Alcohol	Water.	Alcohol.	Water.	Product.	Sp. Gr.	Proof degrees.
Alcohol, 90 p.c.	85·65	—	—	—	—	1000 C.c.	0·834	58 o.p.
Alcohol, 70 p.c.	62·50	777·7 C.c.	241·6 C.c.	648·5 Gm.	241·6 Gm.	1000 C.c.	0·890	22·5 o.p.
Alcohol, 60 p.c.	52·15	666·6 C.c.	357·8 C.c.	555·9 Gm.	357·8 Gm.	1000 C.c.	0·9135	5·5 o.p.
Alcohol, 45 p.c.	37·85	500·0 C.c.	526·6 C.c.	417·2 Gm.	526·6 Gm.	1000 C.c.	0·9435	21 u.p.
Alcohol, 20 p.c.	16·30	222·2 C.c.	791·0 C.c.	185·2 Gm.	791·0 Gm.	1000 C.c.	0·976	65 u.p.

## Spiritus Vini Gallici.

**Brandy** is officially described as a spirituous liquid obtained by the distillation of wine and matured by age, but that description cannot properly be applied to much of the spirit sold under the name. It should contain not less than 36.5 per cent. by weight, or 43.5 per cent. by volume of ethyl hydroxide. Since wine is the product of the fermentation of grape sugar, genuine brandy is flavoured with the volatile products formed during the process of fermentation.

**Characters and Tests.**—Brandy is a pale amber coloured liquid, having a distinctive odour and taste, and a slightly acid reaction. It is colourless when freshly distilled, but it extracts colouring matter from the casks in which it is stored, and colouring matter is sometimes added to it. The quality of brandy is naturally dependent to a great extent upon the wine from which it is prepared, the best being prepared from French wines, and the varieties known as Cognac and Armagnac being most esteemed. Genuine brandy of good quality should be free from fusel oil, added sugar, etc., whilst containing not more than traces of tannin or free acid. If fusel oil or allied impurities should be present, a harsh and unpleasant odour will be perceived when a little of the brandy is exposed on clean white filter paper and the alcohol allowed to evaporate. Added sugar, glycerin, or aromatic substances impart a sweet or distinctly spicy taste to the residue left on evaporating brandy to dryness. If more than traces of oak tannin, derived from casks, be present, a deep green colour will be produced on adding dilute test-solution of ferric chloride. Finally, not more than 1 C.c. of centinormal potassium hydroxide solution should be required to render 100 C.c. of brandy distinctly alkaline.

**Notes.**—In addition to alcohol, water, and volatile oil, brandy contains colouring matter, tannin, ceanthic ether, a little acetic ether, and a little aldehyde. The yellow colour of pale brandy is derived from the casks in which it is kept; the deep red colour of high-coloured brandy is imparted to it by the addition of burnt sugar. An inferior quality of brandy is obtained from the marc or residues from the manufacture of the spirit of better quality, and doubtless much of that found in commerce is entirely factitious, being made by artificially flavouring and colouring plain alcohol, though a little genuine brandy is often added to make the mixture resemble more nearly the product it is intended to represent. Factitious brandy is usually coloured with burnt sugar, and may be flavoured with acetic ether, or with the so-called "oil of cognac," made from wine-lees. The spurious liquid leaves a residue on evaporation, which usually contains sugar. The minimum alcoholic strength of brandy allowed by the Excise authorities is 25 under proof, *i.e.*, it must contain the proportion of alcohol corresponding to 75 parts by measure of proof spirit, and 25 parts by measure of water. Proof spirit represents the alcoholic strength used as a basis for the calculation of spirit duty, and corresponds to a spirit containing 49.24 per cent. of real alcohol and having a



specific gravity of 0.920 at 15.5° C. Proof spirit is legally defined as that which, at the temperature of 51° F. (10.5° C.), weighs  $\frac{1\frac{2}{3}}$  parts of an equal measure of water. The term "proof" probably originated in an old method of testing alcoholic strength by ignition of gunpowder moistened with spirituous liquids, gunpowder damped with spirit lower than proof strength refusing to ignite on the application of a light. The strength corresponding to this rough test has been taken to correspond to the specific gravity and percentage of alcohol mentioned above. Spirits are described as so many degrees over or under proof in relation to the alcohol they contain in 100 parts by measure. Thus 25 under proof indicates that 100 volumes of the spirit contain the quantity of alcohol corresponding to 100—25 or 75 volumes of proof spirit, while 25 over proof means that 100 volumes of the spirit contain so much alcohol as is equivalent to 100+25 or 125 volumes of proof spirit. The 90 per cent. alcohol of the Pharmacopœia corresponds very nearly to 58 over proof, *i.e.*, 100 volumes contain as much real alcohol as 100+58=158 volumes of proof spirit. The limit of alcoholic strength for brandy in the Pharmacopœia, viz., 36.5 per cent. by weight of ethyl hydroxide, corresponds closely with the Excise limit of 25 under proof. Brandy when freshly distilled is "raw" and requires keeping to develop its taste and aroma. The improvement in aroma and taste which occurs during this period is not well understood so far as the actual chemical changes are concerned.

## Staphisagriæ Semina.

**Stavesacre Seeds** are obtained from *Delphinium Staphisagria*, Linné (N.O. Ranunculaceæ), a plant indigenous to Asia Minor and Southern Europe, and cultivated in France and Italy. It produces fruits consisting of three follicles or carpels, which open by a ventral suture to which the closely packed seeds are attached. The seeds are collected when ripe and dried.

**Characters.**—Stavesacre seeds are blackish-brown when fresh, but become dull greyish-brown and dusty on keeping. The dried seeds are about 6 Mm. long, rather less in breadth, and irregularly triangular or obscurely quadrangular in shape, one side being arched or curved outwards, while the others are nearly flat or depressed. The testa or seed-coat bears reticulate ridges which give it a wrinkled appearance, and is deeply pitted, the characteristic markings becoming more evident when the surface is freed from the greyish dust which masks the dark brown colour of the seed. When examined with a lens the elevations and depressions on the seed are seen to be covered with minute papillæ. One end of the seed, near which the hilum is visible as a narrow line, is usually more pointed than the other. If a seed be soaked in water and cut transversely just below the hilum, the minute embryo may be found imbedded in the larger, soft, whitish or yellowish oily endosperm. The drug has no marked odour, but the endosperm has a nauseous, bitter, and acrid taste, due to the presence of alkaloidal matter. Ash-yield, 10 to 13 per cent.

**Notes.**—The active constituents of stavesacre seeds are the bitter, acrid, crystalline, alkaloid, delphinine,  $C_{31}H_{49}NO_7$ , the amorphous alkaloid, delphinidine,

$C_{42}H_{98}N_2O_7(?)$ , which resembles delphinine in its physiological action, and a second crystalline alkaloid named delphisine,  $C_{31}H_{49}NO_7$ , which is identical in composition with delphinine and assumes the same crystalline form. The name staphisagrine has been applied to an amorphous mixture of the three bases. Staphisagroine,  $C_{40}H_{46}N_2O_7$ , is a yellow amorphous base which can be extracted from the mixed alkaloids by the solvent action of chloroform, and can be converted into another, brownish, amorphous base named staphisagroidine,  $C_{40}H_{40}N_2O_4$ , by the abstraction of three molecules of water. Delphinine and delphinoidine are said to resemble aconitine in their action, though weaker, and they constitute the bulk of the total alkaloid (about 1 per cent.) present in the seeds. The endosperm of the seeds also contains about 27 per cent. or more of a fixed oil, which possesses parasiticide properties and appears to owe its physiological activity to alkaloids dissolved in it. Among other constituents, the seeds contain a trace of volatile oil.

## Stramonii Folia.

**Stramonium Leaves** are obtained from the thorn apple, *Datura Stramonium*, Linné (N.O. Solanaceæ), a native of Asia, which is very common on waste ground in temperate and warmer regions. It is cultivated in England, Germany, France, and Hungary, the supply of the drug being largely derived from the last three countries. The leaves may be collected at any time from the appearance of the flowers till the autumnal frosts, and are used in the dried state.

**Characters.**—Stramonium leaves are ovate, unequal at the base, and stalked (petiolate), with a wavy coarsely-toothed (sinuate-dentate) margin and gradually diminishing (acuminate) apex. They vary in length from 10 to 15 Cm., are dark greyish-green in colour and minutely wrinkled on the upper surface, but paler beneath. When dried they are usually much shrivelled and wrinkled. The midrib is distinct on the under surface, and the lateral veins leave it at an angle of about forty-five degrees, dividing near the margin into two branches, one of which passes into the pointed lobe of the leaf, whilst the second unites with other veins, the connection forming a reticulation (anastomosis). Very young leaves are covered with stout curved hairs, but those fall off as growth proceeds, and the full-grown leaves are smooth and destitute of hairs (glabrous), or nearly so. The cells of the mesophyll or interior ground tissue of the leaves contain cluster-crystals of calcium oxalate, which can be seen on submitting a transverse section to microscopical examination. The fresh leaves have a fetid, narcotic odour, which disappears to a considerable extent upon drying. The unpleasant bitter taste is due to the presence of alkaloids. Ash-yield, about 2 per cent.

**Notes.**—The distinctive characters of stramonium leaves are their sinuate-dentate outline, the angle between the midrib and the lateral veins, the presence of cluster-crystals of calcium oxalate in the mesophyll, and the minutely wrinkled surface of the leaves when dried. Belladonna leaves are almost inodorous when dried, and have whitish raised points—consisting of pulverulent

crystals of calcium oxalate—on the surface. Hyoscyamus leaves are hairy and contain prismatic crystals of calcium oxalate. Digitalis leaves are also hairy, but contain no crystals of calcium oxalate. The chief constituents of stramonium leaves are the two isomeric, bitter, crystalline alkaloids, hyoscyamine and atropine, and the amorphous base, hyoscine or scopolamine, formerly known as “amorphous hyoscyamine,” the total alkaloid present being from 0·1 to 0·4 per cent. (average, 0·22). Other constituents of the leaves are gum, resin, etc. Hyoscyamine is present in larger proportion than atropine, and the latter base, apparently, does not pre-exist in the drug, but is formed from hyoscyamine during the process of extraction (*vide* Belladonnæ Radix and Hyoscyami Folia). The name “daturine” has been applied to a mixture of the two alkaloids.

### Stramonii Semina.

**Stramonium Seeds** are obtained from *Datura Stramonium*, Linné (N.O. Solanaceæ). They are contained in large numbers in the fleshy, erect, roundish-ovate, four-valved capsules, which are thickly covered with spines and open at the summit when ripe, the four valves separating from apex to base (septifragal dehiscence). The seeds are collected when ripe, and dried.

**Characters.**—Stramonium seeds are dull dark-brown or nearly black in colour, about 3 to 4 Mm. long, kidney-shaped (reniform), and flattened. The hilum is distinct and appears as a light spot on the concave or flattened edge. The seed-coat is marked with reticulate depressions and minute pits, the latter being seen on the ridges as well as in the depressions, when the seed is examined by the aid of a lens. On splitting a seed longitudinally, a curved embryo can be distinguished, imbedded in a white oily endosperm; in a transverse section the embryo is seen to be rounded or cylindrical, and, owing to its curved shape, it is usually cut at two or three different points. The seeds have no marked odour, but they give off a disagreeable odour when crushed, owing to the fixed oil present. The slightly bitter taste of the seeds is due to alkaloids.

**Notes.**—The chief constituents of stramonium seeds are the alkaloids hyoscyamine, atropine, and hyoscine or scopolamine (*vide* Stramonii Folia), the total alkaloid present being from 0·16 to 0·28 (average 0·22) per cent., of which the major portion is hyoscyamine. Among other constituents are resin and about 25 per cent. of a fixed oil which has a slight odour of valeric acid and contains daturic acid, a homologue of palmitic and stearic acids.

### Strophanthi Semina.

**Strophanthus Seeds** are obtained from *Strophanthus Kombé*, Oliver (N.O. Apocynaceæ), a plant which is indigenous to eastern tropical Africa. The fruit is a pod consisting of two follicles, about 30 Cm. long and 2·5 Cm. broad, which are slightly narrowed at the base, and tapered towards the apex. It ripens in June and, when collected by the natives, is deprived of its husks, consisting of the epicarp and fleshy mesocarp, before drying, so that the smooth tawny-coloured pods which appear in commerce consist simply of the leathery endocarp enclosing the ripe seeds, packed closely together.



Each seed, at its apex, has a long plume (awn) of white silky hairs, about 5 Cm. long, attached by a slender, brittle extension of the seed-coat, the entire seed measuring from 9 to 12 Cm. in length. The seeds must be freed from their awns before use, and are usually separated from the fruits and deprived of their awns before exportation. They are imported chiefly from Somba, Quilimane, Inhambane, and other East African ports, and are known in commerce as "Kombé" seeds. The drug is intensely poisonous.

**Characters and Tests.**—*Strophanthus* seeds vary considerably in shape and size. They are generally more or less elongate-oval in shape, gradually diminishing (acuminate) towards the apex, and are also narrowed towards the blunt (obtuse) or rounded base. When deprived of their awns they measure about 15 Mm. in length and 4 Mm. in breadth. They vary in colour from greyish-green to greenish-fawn, and are covered with stiff (not "silky"), silvery hairs, which lie flat (oppressed) on the seeds. The latter are flattened and have a longitudinal ridge extending half or two-thirds the length of the seed, and terminating at the apex in a broken point, indicating where the awn has been broken off. The scar of the funicle appears at some point on this ridge as a small, white dot. The nucleus or embryo of the seed is white and oily, consisting of two straight cotyledons, joined by a well-marked radicle, and surrounded by a thin endosperm or albumin, as may be seen in a transverse section. The seed-coats and endosperm are longitudinally ridged and grooved, the grooves in the seed-coats being filled up with the appressed epidermal hairs. Strong sulphuric acid (s.g. 1.843) colours a transverse section dark green, owing to the presence of strophanthin, the action being constant in the case of the endosperm, but variable as regards the embryo; thus, the cotyledons may exhibit varying shades of green, or green mottled with red, or one cotyledon may be coloured green and the other red, the red colouration being due to the presence of sugar. The faint, unpleasant odour of the seeds is probably due to the fixed oil present; the intensely bitter taste is due to strophanthin.

**Notes.**—The seeds of *S. hispidus*, De Candolle, also give a green colour with sulphuric acid, but they have a distinctly brown colour, and bear but few brownish, usually short, hairs and do not possess the silvery appearance which characterises the official seeds. Other species of *Strophanthus* produce seeds which differ in colour, etc., from those of *S. Kombé*, and their transverse sections are usually coloured red instead of green by sulphuric acid. The colour of the genuine seeds varies with the position of the observer with regard to the seed and to the incident light, owing to the disposition of the stiff, silvery hairs, which point upwards and are arranged in longitudinal rows; when the hairs are removed by scraping, the seeds appear green or brownish-green. It should be noted that no seeds have yet been obtained which are known definitely to have been collected from *Strophanthus Kombé*, and that the "Kombé" seeds of commerce are probably derived from several species of *Strophanthus*; also that seeds from the same pod may differ considerably in shape, size, and colour. The chief constituent of strophanthus seeds is the exceedingly poisonous, bitter, crystalline glucoside, strophanthin,  $C_{40}H_{66}O_{19}$ , of which they may contain from 8 to 10 per cent., chiefly in the

endosperm. It melts at  $170^{\circ}\text{C.}$ , gives a green coloration with strong sulphuric acid, and is converted into a sugar (strophanthobiose methyl-ether) and strophanthidin (m. p.  $169^{\circ}$  to  $170^{\circ}\text{C.}$ ) on hydrolysis. Other constituents of the seeds are choline, trigonelline, kombic acid, resin, mucilage, and fixed oil. Pseudo-strophanthin,  $\text{C}_{40}\text{H}_{60}\text{O}_{10}$ , a glucoside found in the seeds of some species of *Strophanthus*, is more active than strophanthin and yields saccharobiose and pseudo-strophanthidin (m. p.  $195^{\circ}\text{C.}$ ) on hydrolysis; it melts at  $179^{\circ}\text{C.}$ , and gives a red coloration with sulphuric acid, but a similar colour may be produced by sugar present in the seeds. The name "ouabain" has been applied to an intensely poisonous glucoside which has been extracted from some strophanthus seeds, but it appears probable that it is identical with pseudo-strophanthin.

## Strychnina.

**Strychnine**,  $\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2$ , is an alkaloid obtained from the dried ripe seeds of *Strychnos Nux-vomica*, and other species of *Strychnos*. It may be prepared by exhausting the seeds with alcohol, recovering the alcohol from the tincture by distillation. The residue is dissolved in water, colouring and other matter being precipitated by acetate of lead. The filtrate, after removal of lead by hydrogen sulphide and evaporation to a low bulk, is mixed with lime or magnesia, and the liberated alkaloids are removed with alcohol. The alcoholic solution contains both strychnine and brucine, which can be separated by fractional crystallisation, brucine being much more soluble in alcohol than strychnine.

**Characters and Tests.**—Strychnine crystallises in trimetric prisms, colourless and inodorous. It is soluble in about 7,000 parts of water, the solution having an intensely bitter taste, in 150 parts of 90 per cent. alcohol, more soluble in boiling 90 per cent. alcohol, and in 6 parts of chloroform; slightly soluble in cold absolute alcohol, but readily in 40 parts of boiling absolute alcohol, and nearly insoluble in ether. Sulphuric acid forms with it a colourless solution, which on the addition of potassium bichromate acquires an intensely violet hue, speedily passing through red to yellow. When sulphuric acid containing a minute proportion of potassium permanganate ( $\frac{1}{2000}$  part) is brought into contact with strychnine a violet coloration results. Strychnine is not coloured by strong nitric acid, this test serving to distinguish it from brucine or to detect the latter as an impurity since it gives an intense red coloration with that fluid. Strychnine should leave no ash when incinerated.

**Notes.**—The absence of coloration when strychnine is dissolved in sulphuric acid distinguishes it from many organic substances which are easily charred, and from others, like salicin, which give colour reactions with that reagent. When heated with sulphuric acid alone to  $100^{\circ}\text{C.}$ , strychnine forms a sulphonic acid derivative. The violet colour reaction so characteristic of the base when treated with sulphuric acid and potassium bichromate may also be produced by many other oxidising agents, e.g., puce-coloured oxide of lead or black oxide of manganese, the latter being preferred by some, as the coloration is not so transient as that produced by the bichromate. Brucine is closely related to strychnine and appears to be di-methoxy-strychnine. [Dose.— $\frac{1}{60}$  to  $\frac{1}{15}$  grain.

## Strychninæ Hydrochloridum.

**Strychnine Hydrochloride**,  $C_{21}H_{22}N_2O_2 \cdot HCl \cdot 2H_2O$ , is obtained by neutralising strychnine with hydrochloric acid and crystallising the resulting salt.

**Characters and Tests.**—Strychnine hydrochloride crystallises in small trimetric prisms which readily effloresce in the air, soluble in 35 parts of water or in 60 parts of 90 per cent. alcohol, forming a solution which is neutral to litmus and intensely bitter. It should respond to the qualitative test given under “Strychnina,” should afford the reactions characteristic of hydrochlorides, and be free from sulphates. Dried at a temperature of  $100^\circ C$ . it should lose from 7.3 to 8.8 per cent. of moisture.

**Notes.**—The variation in the loss of weight on drying is presumably allowed in view of the statement that this salt is efflorescent, a loss of 8.8 per cent. corresponding closely to the amount indicated by the formula given. There is, however, some doubt about the amount of water of crystallisation, some authorities giving it as  $1\frac{1}{2}$  molecules in place of 2 molecules of water, as stated in the Pharmacopœia. The comparative solubilities of strychnine and those of its commonly used salts (hydrochloride, nitrate, and sulphate) in water are very different. This point is of great importance in dispensing, for strychnine is frequently given with an alkali (aromatic spirit of ammonia, sodium bicarbonate, etc.) in water, or other aqueous vehicle. In such cases the strychnine is usually prescribed in the form of *Liquor Strychninæ Hydrochloridi*, and is therefore easily soluble in the proportion of water in the prescription. If an alkali is prescribed also, then a condition of things arises which may have serious consequences. For the strychnine, liberated by the free alkali acting on the strychnine hydrochloride, is very sparingly soluble in water (about 1 in 7,000); therefore if the weight of strychnine prescribed relative to the vehicle exceed this proportion, the excess will be precipitated—probably not immediately, but on standing some time—and fall to the bottom of the bottle, so that an excessive quantity of strychnine may be taken in the later doses of the mixture. The proportion 1 in 7,000 corresponds in round numbers to 8 minims of *Liquor Strychninæ Hydrochloridi* per fluid ounce for

$$7,000 : 1 :: 437.5 : 0.0625$$

That is, if the quantity of strychnine exceed the proportion of 0.0625 grains per fluid ounce, then a precipitate of strychnine will be produced. Now, 110 minims of the *Liquor Strychninæ Hydrochloridi* contain 1 grain of the hydrochloride, which is equivalent in round numbers to 0.8 grain of the free alkaloid—

∴ if 0.8 grain strychnine is contained in 110 minims

$$1.0 \quad \text{,,} \quad \text{,,} \quad \text{,,} \quad \frac{110}{0.8} \quad \text{,,}$$

$$\text{and } 0.0625 \quad \text{,,} \quad \text{,,} \quad \text{,,} \quad \frac{110 \times 0.0625}{0.8} \quad \text{,,}$$

$$= 8.59 \text{ minims}$$

It is therefore unsafe to dispense alkaline “mixtures” containing more than 8 minims of the official solution per fluid ounce. [*Dose.*— $\frac{1}{10}$  to  $\frac{1}{15}$  grain.]



## Styrax Præparatus.

**Prepared Storax** is the purified balsam obtained from the trunk of *Liquidambar orientalis*, Miller (N.O. Hamamelideæ), a native of Asia Minor. The bark of the tree contains secretion ducts, but those do not appear to be concerned in the production of storax, the balsam being a purely pathological product, which is not found in the tree under normal conditions. When, however, the bark is wounded, secretion reservoirs (schizo-lysigenous ducts) are formed by the splitting of the common walls of the cells of the young wood and by the breaking down of surrounding tissues; the cavities become filled with the balsam formed by the transformation of part of the tissues, and the viscid liquid subsequently exudes into the wooded bark. The secretion of balsam is induced artificially, by making incisions in the bark or beating it gently during the summer, the balsam being collected later. As the oleo-resin is found in the inner bark only, the outer bark is first separated from the trunk and rejected; the inner bark is then removed by scraping and pressed until the balsam exudes, or it is boiled with sea-water and then pressed. In the former case a further supply of balsam may be obtained from the bark, after expression by boiling it with water and skimming off the resin which separates, or by pouring boiling water upon it and again applying pressure. The residuary bark was formerly known in commerce as "Cortex Thymiamatis," and a mixture of the coarsely powdered bark with liquid storax has been sold as "Styrax Calamita." The crude balsam is an opaque, greyish, viscid liquid, which separates into two parts on long standing, an aqueous layer forming on the surface of a dark brown mass of oleo-resin. When heated on a steam-bath the crude balsam loses from 10 to 25 per cent. or more of water; it also usually contains fragments of bark and other vegetable débris, together with inorganic impurities, some of which have probably been derived from the sea-water used in extracting the drug. For medicinal purposes the portion of the crude balsam which is soluble in ethylic alcohol must alone be used. It is officially directed that prepared storax should be prepared by solution in ethylic alcohol (? 90 per cent.), filtration and evaporation of the solvent, but, as the drug loses some of its volatile constituents during the process of evaporation, a finer product would be obtained if the balsam were purified by solution in ether or acetone.

**Characters and Tests.**—Prepared storax (specific gravity, 1.109 to 1.114 at 100° C.) is semi-transparent, brownish-yellow, and semi-liquid, with a strong and agreeable odour, due to the presence of styrene and other aromatic principles, and a sharp, pungent, "balsamic" taste which is chiefly due to styrene and cinnamic acid. It should be completely soluble in 90 per cent. alcohol, ether, chloroform, carbon bisulphide, glacial acetic acid, and in most essential oils. When a test-tube containing prepared storax is placed in boiling water the contents should become more fluid, whilst if the drug has not been properly purified and contains water moisture will be given off. An odour resembling that of essential oil of bitter almonds is evolved on boiling prepared storax with solution of potassium bichromate and sulphuric acid,

owing to the formation of benzaldehyde as a product of the oxidation of the cinnamic acid and its compounds benzoic acid is also formed.

**Notes.**—From 60 to 80 per cent. of crude storax is soluble in alcohol; the soluble portion should be practically free from moisture and leave no ash on incineration. The absence of turpentine, fixed oils, or added resin is indicated by the formation of only a slight froth when prepared storax is mixed with an equal volume of 90 per cent. alcohol and shaken with ammonia. Storax contains a resin and an oily liquid, the resin consisting of storesinol, partly free and partly combined with cinnamic acid, while the oily liquid is a mixture of phenyl-propyl, cinnamyl (styracin), and ethyl cinnamates, together with free cinnamic acid, vanillin, and phenyl-ethylene, which is variously known as styrol, styrene, or cinnamene. Benzoic acid is said to be absent. Phenyl-propyl cinnamate is an inodorous oily liquid; styracin or cinnamyl cinnamate occurs in colourless, odourless, and tasteless crystals, from which cinnamic alcohol (styrone) and a salt of cinnamic acid are formed on hydrolysis by potassium hydroxide. Styrol or phenyl-ethylene is a colourless liquid possessing the odour and pungent taste of storax; when kept for a considerable time at a temperature of 100° C. it is converted into solid metastyrol (metastyrene or metacinnamene), which is insoluble in alcohol or ether. Storax may yield as much as 47 per cent of cinnamic acid, and is the best source of that compound. The volatile oil of storax (specific gravity, 0.89 to 1.1) is present to the extent of 0.5 to 1 per cent. It is lævo-rotatory and varies in specific gravity according as the hydrocarbons or cinnamic esters predominate in its composition. Its peculiar odour is due to the presence of styrol, and its optical activity is probably due to an oxygenated constituent, styrocamphene; the oil also contains varying proportions of the cinnamates of ethyl, phenyl-propyl, and cinnamic alcohols. American storax, from *L. Styraciflua*, contains free cinnamic acid, vanillin, styresinol (a substance closely resembling storesinol) and its cinnamic ester, styracin, cinnamic phenyl-propyl ester, styrol, and a volatile oil which differs from that of Levant storax in being dextro-rotatory.

## Succi.

**Juices** used in medicine are obtained by expressing certain fresh vegetable drugs and (except in the case of *Succus Limonis*) adding to every three volumes of juice one volume of 90 per cent. alcohol. The addition of the alcohol causes the precipitation of gummy and albuminous substances, and after standing seven days to allow the precipitate to coagulate and subside the product is filtered. The alcohol thus serves to remove some of the inert constituents of the juice which during subsidence entangle and carry down the cell débris and other particles which impart a turbid appearance to the expressed juice. It also preserves the filtrate from subsequent decomposition. The idea underlying the employment of these expressed juices is that they represent the medicinal properties of the drugs from which they are

prepared unimpaired by chemical change during manipulation, *e.g.*, such as sometimes follows the application of heat during evaporation, and unaltered by the selective action of solvents which may extract certain substances and exclude others from the preparation in which they are employed. These considerations formerly exercised more weight than they do at present; for as our knowledge increases of the active principles of drugs and their medicinal action it becomes possible to produce preparations having the desired activity and more uniformity than the expressed juices. Investigation has shown that these vary considerably in potency; the variation may be due not only to differences caused by soil, season, climate, etc., to which all vegetable drugs are liable, but also to differences in the relative quantity of moisture present in the tissues of any given sample at the time of expression. Belief in the superior efficacy of crude drugs as opposed to that of their known active principles is also not so strong as formerly, and in many cases has been shown to be without sufficient foundation. For various reasons the juices now find comparatively restricted use in medical treatment. The following are the official representatives of this class of preparation, all being preserved by the addition of alcohol except lemon juice, which is used fresh:—

Juice.	Dose.	Juice.	Dose.
<b>Succus Belladonnæ</b>	5 to 15 minims.	<b>Succus Limonis</b>	—
<b>Succus Conii</b> ...	1 to 2 fl.drachms.	<b>Succus Scoparii</b>	1 to 2 fl.drachms.
<b>Succus Hyoscyami</b>	$\frac{1}{2}$ to 2 fl.drachms.	<b>Succus Taraxaci</b>	1 to 2 fl.drachms.

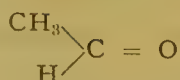
**Notes.**—Lemon Juice has a specific gravity of 1·030 to 1·040 and should contain 30 to 40 grains of citric acid per fluid ounce. Evaporated and incinerated it should leave not more than 3 per cent. of ash showing the absence of added mineral substances, used either as preservatives or to increase the specific gravity.

## Sulphonal.

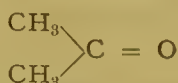
**Sulphonal**, or dimethyl-diethyl-sulphone-methane  $(\text{CH}_3)_2\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$ , is a product of the oxidation of mercaptol  $(\text{CH}_3)_2\text{C}(\text{SC}_2\text{H}_5)_2$ , a substance obtained from acetone and mercaptan. The systematic name, dimethyl-diethylsulphone-methane, indicates that sulphonal is a derivative of the simplest paraffin hydrocarbon methane,  $\text{CH}_4$ . Two of the four hydrogen atoms are replaced by methyl ( $\text{CH}_3$ —) groups, hence the prefix dimethyl, and the other two by two ethyl sulphone ( $-\text{SO}_2\cdot\text{C}_2\text{H}_5$ ) groups. Although the constitution of sulphonal can thus be simply explained, it must not be supposed that it can be, or actually is, prepared directly from the parent substance methane. The process of preparation involves some reactions somewhat unfamiliar to the student, and not dealt with in the elementary text-books of organic chemistry. In order to explain them as simply as possible, it will be necessary to draw some analogies between those reactions and some of more fundamental importance with which



the student should be familiar. Starting with ordinary aldehyde, whose constitution is represented thus—



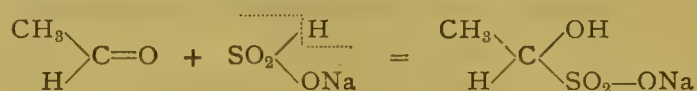
and acetone, the simplest ketone,



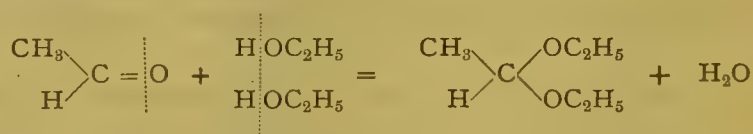
it will be observed that both bodies contain a carbonyl group  $>\text{C}=\text{O}$ , *i.e.*, oxygen doubly linked with carbon. The presence of this group enables both aldehydes and ketones to form additive compounds through a change in the relation of the carbon and oxygen of the carbonyl group which is usually expressed thus :—



This change enables the aldehydes and ketones to take up two monovalent elements or groups, as, for instance, in the formation of the bisulphite compound with sodium acid sulphite—



Compare also the behaviour of aldehydes and ketones with hydrocyanic acid, ammonia, and hydroxylamine. Aldehyde also condenses with two molecules of alcohol to form acetal—



This substance, acetal, being the best known member, has given its name to a class of bodies, the acetals, which are regarded as derived from a hypothetical dihydric alcohol containing the two hydroxyl groups attached to the same carbon atom. As already mentioned under chloral hydrate, dihydric alcohols of this constitution can only exist in the free state when the compound contains

electro-negative groups or atoms, as in the case of chloral hydrate  $\text{CCl}_3\text{CH} \begin{array}{l} \diagup \text{OH} \\ \diagdown \text{OH} \end{array}$ .

Otherwise, whenever we attempt to isolate these dihydric alcohols a molecule of water is split off and an aldehyde is obtained—



Although these alcohols are therefore unknown in the free state, we can obtain derivatives—the acetals—in which the hydroxylic hydrogen is replaced by alkyl residues. Thus ordinary acetal, referred to above, may be called diethyl acetal, because the replacing groups are ethyl,  $\text{C}_2\text{H}_5$ . The general formula for the

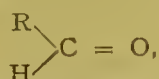
acetal group may be therefore put as  $\text{R—HC} \begin{array}{c} \diagup \text{OR} \\ \diagdown \text{OR} \end{array}$ . In an analogous manner

aldehyde condenses with thio-alcohols (mercaptans), which are the sulphur

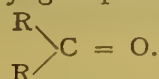
analogues of ordinary alcohols. Thus, aldehyde gives with ethyl mercaptan a body having the constitution of a thio-acetal, and these bodies are called *mercaptals*, to recall their origin from aldehydes and mercaptans.



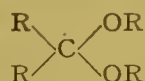
Passing now to acetone, compare the similarity between the reactions of aldehydes and ketones, which are due to the presence in both classes of bodies of the carbonyl group  $>\text{C} = \text{O}$ . Note then the differences in their reactions, which are due to the carbonyl group of the aldehydes being connected with an alkyl group and hydrogen



whereas in the ketones the carbonyl group is connected with two alkyl groups,



Among the compounds formed by the ketones, the group analogous to the acetals, and which would have the general formula

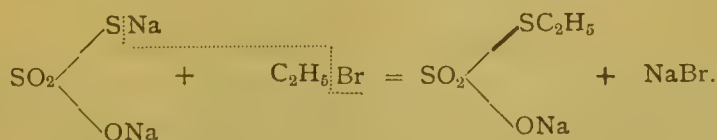


is not known.

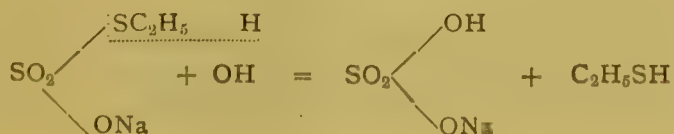
The sulphur compounds analogous to the mercaptals are, however, known, and are called *mercaptols*. The best known member is the dimethyl-diethyl mercaptol, mentioned in the Pharmacopœia, which is usually called simply mercaptol, and is obtained by the condensation of one molecule of acetone and two of ethyl mercaptan—



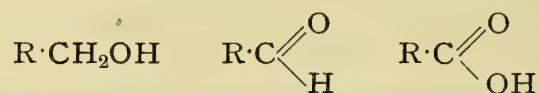
Mercaptan is a very volatile fluid of extremely unpleasant odour. In order to avoid the disagreeable effect of working with considerable quantities, as in the manufacture of sulphonal, it is said that sodium ethyl thiosulphate is employed. The substance is obtained by the action of ethyl bromide upon sodium thio-sulphate—



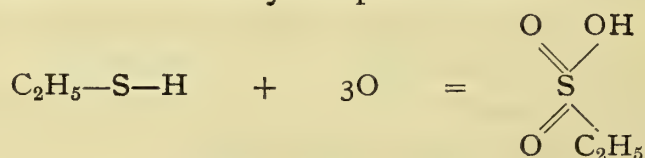
The sodium ethyl thiosulphate is heated with the acetone in presence of hydrochloric acid. Under the influence of the acid the thiosulphate reacts with water and undergoes hydrolysis into mercaptan and sodium acid sulphate—



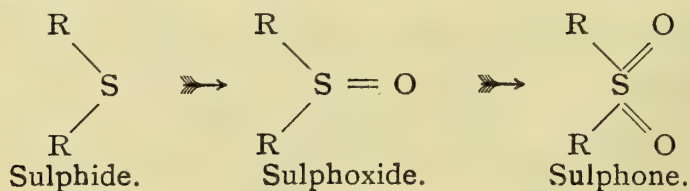
The mercaptan reacts with the acetone as fast as it is liberated, so that the disagreeable effects of working with large quantities of free mercaptan are avoided. In order to explain the next step—the oxidation of the mercaptol to a di-sulphone—compare the behaviour towards oxidising agents of alcohols and thio-alcohols (mercaptans). The former first lose hydrogen, and then take up oxygen with formation of aldehydes and acids, *i.e.*, the alkyl residue is attacked—



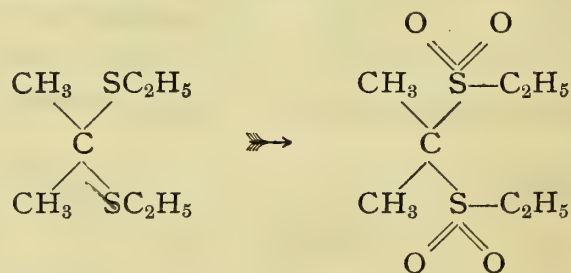
These changes are consistent with the divalent nature of oxygen. The sulphur analogues, on the other hand, readily take up oxygen, due to the fact that sulphur is capable of exhibiting tetravalent and hexavalent properties (compare  $\text{SO}_2$  and  $\text{SO}_3$ ). Thus mercaptan, when oxidised by nitric acid or permanganate, is converted into ethyl sulphonic acid.



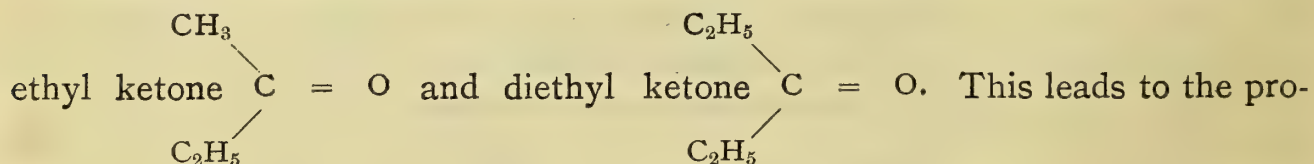
If alkyl sulphides  $\text{R}_2\text{S}$  be oxidised, two atoms of oxygen are taken up, and a sulphone is obtained, compounds called sulfoxides being obtained as intermediate products—



By comparing the constitutional formula for mercaptol it will be seen to contain two sulphur atoms in the condition of sulphide, *i.e.*, each sulphur atom is connected with two alkyl residues. When mercaptol is oxidised it therefore takes up four atoms of oxygen and yields di-ethylsulphone dimethyl methane, *i.e.*, sulphonol—



Homologues of sulphonol have been prepared, using in place of acetone, methyl,



This leads to the production of methyl-, ethyl-, and diethyl, diethyl sulphone methane  $(\text{CH}_3)(\text{C}_2\text{H}_5)\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$  and  $(\text{C}_2\text{H}_5)_2\text{C}(\text{SO}_2\text{C}_2\text{H}_5)_2$  respectively, which have been introduced as hypnotics under the names of trional and tetronal. If the ethyl groups in



ordinary sulphonal be replaced by methyl by employing methyl mercaptan in place of ethyl mercaptan, the resulting compound is devoid of hypnotic properties.

**Characters and Tests.**—Sulphonal (m.p.  $125.5^{\circ}\text{C.}$ ) forms colourless, inodorous, nearly tasteless prismatic crystals, which are neutral to litmus. It is soluble in about 500 parts of cold water, 15 parts of boiling water, or 50 parts of 90 per cent. alcohol, very soluble in boiling alcohol, and also soluble in ether. Heated to redness with free access of air it burns, its sulphur being given off as sulphurous anhydride, which is easily recognisable by its odour, and leaving no ash, showing absence of mineral impurities. Sulphonal and other sulphones are very stable bodies; they are hardly affected by boiling acids or alkalis. When heated in the dry state with potassium cyanide they are, however, decomposed. The cyanide acts as a reducing agent, and removes the oxygen of the sulphone group, causing a complicated decomposition to ensue, among the products of which the mercaptan, owing to its odour, is easily distinguished. At the same time the cyanide unites with some of the sulphur, forming potassium thiocyanate, KCNS. Hence, if the fused residue, obtained by heating a mixture of equal parts of sulphonal and potassium cyanide, be dissolved in water and treated with a slight excess of hydrochloric acid, the resulting solution yields the red colouration with ferric chloride, which is characteristic of thiocyanates (compare iron test for acetates and meconates). It is necessary to use a slight excess of hydrochloric acid, in order to convert into chloride the excess of cyanide and some carbonate which is always present in the fused residue, and which would subsequently interfere with the reaction between the thiocyanate and ferric chloride. When heated gradually with dried sodium acetate, the sulphur of the sulphonal is evolved as hydrogen sulphide. Sulphonal should be free from sulphates and chlorides.

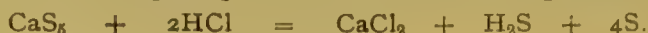
**Notes.**—In dispensing sulphonal its sparing solubility in cold water should be remembered. That renders it desirable to administer the substance in the finest possible powder. Copious draughts of some warm fluid after administration also accelerate solution, and promote prompt action, since sulphonal is much more soluble in hot water than in cold.

[Dose.—10 to 30 grains.]

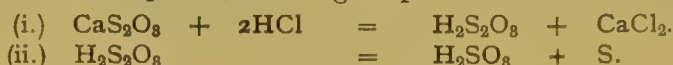
## Sulphur Præcipitatum.

**Precipitated Sulphur**, also known as “milk of sulphur,” is obtained as a milky precipitate by the addition of hydrochloric acid to a solution of calcium sulphides and thiosulphate. This solution is obtained by boiling sublimed sulphur with calcium hydroxide and water, when a complex mixture of compounds is formed, the composition of which varies with the proportion of materials employed, the prolongation of boiling, and other conditions. The chief constituents of the resulting solution appear to be polysulphides of calcium (*i.e.*, sulphides containing more sulphur than corresponds to the monosulphide  $\text{CaS}$ ) and calcium thiosulphate. When diluted, hydrochloric acid is added to the filtered fluid, the polysulphides are decomposed with formation of calcium

chloride, and the sulphur which is in excess of that corresponding to the ordinary salts of calcium is precipitated: thus with the pentasulphide—



If sufficient hydrochloric acid be added to render the fluid finally acid, the thiosulphate is also decomposed, forming sulphurous acid and more sulphur—



The sulphurous acid then reacts with the sulphuretted hydrogen produced from the calcium sulphides, thus forming more sulphur—



In practice, however, it is better to leave the precipitated liquid slightly alkaline, as any arsenic present is thereby retained in the liquid as a soluble thio-arsenite. If excess of acid be employed this thio-arsenite is decomposed and arsenic sulphide precipitated with the sulphur.

**Characters and Tests.**—Precipitated sulphur is a greyish white, soft powder, free from grittiness and from the smell of hydrogen sulphide. Under the microscope the powder is seen to be devoid of crystalline structure, and consists of opaque, globular particles. It should respond to the test described under Sulphur Sublimatum.

**Notes.**—Milk of sulphur was formerly made by employing sulphuric acid in place of hydrochloric acid to precipitate the sulphur from the calcium polysulphide solution. That resulted in the formation of the sparingly soluble calcium sulphate, which was precipitated along with the sulphur. Such precipitated sulphur left an ash of calcium sulphate when burnt, whereas the present official variety leaves no residue; for, calcium chloride, being soluble, is easily removed by washing with water. [*Dose.*—20 to 60 grains.]

## Sulphur Sublimatum.

**Sublimed Sulphur**, also known as “flowers of sulphur,” is prepared from native sulphur or sulphides. The chief source is the native crude sulphur found in volcanic districts mixed with gypsum and other mineral substances. Lumps of this are piled up, covered with earth to limit the access of air, and then fired from below. The heat produced by the combustion of a portion of the sulphur melts the rest, which runs away through holes in the base of the heaps leading into vessels in which the sulphur is collected. This crude sulphur is purified by distillation from iron retorts, the vapours being passed into capacious brick condensing chambers. If the distillation be conducted slowly the sulphur vapour is condensed in a snow-like form and constitutes “flowers of sulphur,” but if the rate of distillation be rapid the temperature of the condensing chamber rises above 120° C., the melting point of sulphur, and the sulphur is collected in liquid form, as it also is when produced as a bye-product (by burning sulphuretted hydrogen with air in Claus kilns) in the manufacture of caustic soda from salt-cake. The liquid is run off from time to time and cast in moulds, giving the familiar form of the roll sulphur of commerce. Flowers of sulphur was originally obtained by the first method of condensation described.



but much of the commercial "flowers of sulphur" is produced by powdering roll sulphur.

**Characters and Tests.**—Sublimed sulphur is a slightly gritty powder of a bright greenish-yellow colour, tasteless and odourless when pure, although that usually met with in commerce and used in medicine has a distinctly perceptible and characteristic odour. When examined under the microscope it is seen to consist of almost opaque irregular particles not possessing any definite crystalline structure. It burns with a blue flame producing sulphurous anhydride and leaving no fixed residue. When moistened, it should have no action on litmus paper. Solution of ammonia agitated with it, and filtered, does not leave any residue on evaporation. Arsenic sulphide, if present, will be dissolved, forming ammonium thio-arsenite, pure sulphur being insoluble in ammonia, except at high temperatures.

**Notes.**—The official characters and tests for "Sulphur Sublimatum" accord with the properties of sulphur which has been previously digested with ammonia water and washed, although no directions are given for this in the official monograph. During sublimation, and particularly at the commencement, the access of air cannot be entirely prevented and this leads to combustion of a portion of the sulphur. The first product of oxidation sulphurous anhydride, by the moisture and air, is further oxidised to sulphuric acid and the sublimed product hence contains traces of sulphurous and sulphuric acids, to which its acid reaction and slight odour are chiefly due. Sulphur which has been washed acquires again an acid reaction by the action of air and moisture, if stored so that these can gain access to it.

[Dose.—20 to 60 grains.

## Sulphuris Iodidum.

**Sulphur Iodide** is made by fusing, in a nearly closed flask, an intimate mixture of 1 part sublimed sulphur, and 4 parts iodine. The black product is allowed to cool without further exposure to air, the solidified product removed by breaking the flask, and preserved in well-closed vessels.

**Characters and Tests.**—Sulphur iodide occurs in greyish-black solid fragments with a radiating crystalline structure. It has an odour of iodine and stains the skin brown. Soluble in 60 parts of glycerin but insoluble in cold water. When boiled with water, the compound is dissociated into its elements, the iodine passing off with the steam, leaving the sulphur in the aqueous residue. If the compound has been correctly prepared with the proper proportions of ingredients, this sulphur residue should weigh one-fifth the amount of the iodide of sulphur taken.

**Notes.**—The proportions of iodine and sulphur correspond very nearly to those of the atomic weights of the two substances, viz., 125.9 and 31.82. The compound is however a very weak one, and combination is probably never complete.

## Sumbul Radix.

**Sumbul Root** is obtained from *Ferula Sumbul*, Hooker filius (N.O. Umbelliferæ), a plant which grows in Turkestan and produces a large fleshy,



somewhat napiform root with a bristly rootstock or erect rhizome. The root gives off numerous twisted rootlets in the early spring and increases in size every year, retaining its more or less oval form until it has accumulated a sufficient reserve of nutritive materials to enable it to send up a large fruiting stem. As found in commerce and used in medicine, the drug occurs in dried transverse slices of varying size, many of which are parts of rootstocks or erect rhizomes rather than roots, whilst others appear to be derived from a plant—probably *F. suaveolens*—with a more cylindrical root than that of *F. sumbul*, having a firmer substance and branched near the apex.

**Characters.**—Sumbul root occurs in extremely light, more or less cylindrical pieces, which vary much in size, but are usually from 2.5 to 7.5 Cm. in diameter, and from 15 to 25 Mm. or more in thickness. The pieces are covered externally with a thin, tough, papery, dusky-brown, transversely-wrinkled cork, which can be stripped off easily. Pieces derived from the crown or rootstock are also beset with short bristly fibres—the remains of the fibro-vascular bundles of leaves. The fibres, or scars showing where they have been, are arranged in encircling lines which follow the course of the regular transverse wrinkles in the bark. Internally the drug is spongy, coarsely fibrous, and of a dirty yellowish colour, mottled with whitish patches and often with blackish spots of exuded resin. A transverse section of a small piece of rootstock shows a pale bark enclosing a ring of narrow, yellow, finely-porous wood-bundles, and a central mass of parenchymatous tissue through which vascular bundles pass in different directions. The fibrous nature of the drug appears to be due to this arrangement of the vascular bundles, which is usually less marked in larger pieces of rootstock. The strong musk-like odour and bitter, aromatic taste of the drug are due to the presence of volatile oil and resin.

**Notes.**—The distinctive characters of sumbul root are the transverse wrinkles in the cork, from which the short fibres proceed, the musky odour, and the fibrous, spongy interior, with its whitish spots. The drug contains volatile and fixed oils, a resin with a musk-like odour, angelic (sumbulic), valerianic, and methyl-crotonic acids, a bitter principle, starch, and sugar; on dry distillation it yields umbelliferone. The volatile oil (specific gravity 0.954 to 0.964), of which the drug yields from 0.2 to 0.4 per cent., is viscous, dark-coloured, and has a musk-like odour, like that of the resin. Nothing is known regarding its composition.

## Suppositoria.

**Suppositories** are solid bodies, usually of conical shape, with a rounded apex, intended for introducing medicine into the rectum. Preparations of a similar character, moulded into suitable shapes, are employed for introduction into the urethral or vaginal passages; those are known as bougies or pessaries respectively. It is necessary that suppositories should retain their shape at ordinary temperatures, but readily soften or melt at the temperature of the body. The suppositories of the Pharmacopœia are all prepared with oil of the theobroma as a basis, with the exception of glycerin sup-

positories. In the formula for phenol suppositories a proportion of white beeswax is introduced to compensate for the depression of melting point caused by the addition of phenol to oil of theobroma. The monograph on *Oleum Theobromatis* should be read carefully, in order that a clear comprehension may be obtained of the nature and physical properties of that fat, which have led to its adoption for making suppositories. The general official process is described under Tannic Acid Suppositories, and is adapted with slight variations to produce other suppositories. One is directed to take "a sufficient quantity (of oil of theobroma) to form with the tannic acid a mixture which will fill twelve suitable moulds, each capable of holding fifteen to sixteen grains (or about one gramme) of oil of theobroma." The melted mixture may be poured into moulds of the required form; or it may be allowed to cool and then moulded by cold compression. Numerous appliances are procurable for this purpose, but the practice almost universally followed in this country is to pour the melted mixture into moulds and allow it to solidify. The accurate dosage of the medicament will therefore depend upon the moulds having the capacity indicated. Since moulds of the requisite degree of accuracy cannot be obtained, the pharmacist must determine for himself the capacity of the moulds he employs, if accurate results are desired. The weight of the melted mixture received by a mould of given capacity will obviously be influenced by (*a*) variations in the specific gravity of oil of theobroma, (*b*) density of the added medicament, (*c*) temperature of the melted mixture at the time of pouring. Further information on those points will be found in the *Pharmaceutical Journal* [4], 5, 437, and [4], 6, 69. In making suppositories the melted mixture should only be heated sufficiently to just liquefy it; a higher temperature will cause the medicament to separate—sometimes in an unmanageable clot. The melted mixtures for iodoform and compound lead suppositories should be assiduously stirred on account of the density of the medicaments in order to effect a uniform distribution of the materials. In making all suppositories with oil of theobroma, care should be taken to keep the temperature of the melted oil as low as possible, and the mixture should not be poured into the moulds until it is beginning to thicken preparatory to setting. In making any desired number of suppositories—say six or twelve—it is necessary to mix materials for one or two extra to allow for the inevitable loss in manipulation. Do not add a piece of oil of theobroma without the corresponding quantity of medicament, for in this case 15 grains of the mass will not contain the full quantity of medicament ordered. It is usual to lubricate the surface of the moulds with oil, soft soap, or soap liniment; these can, however, be dispensed with if the moulds be well cooled, and the mixture poured in just before it is going to solidify. In winter immersion in cold tap water is sufficient, but in summer the use of iced water is advantageous. To obtain a well-finished product it is best to slightly overfill the moulds, and then, after solidification, remove the excess by means of a sharp knife, flush with the surface of the metal. If the moulds be only just filled the contraction which ensues during solidification causes the formation of an irregular pit in the base of the suppository. There are seven official

suppositories, of which the first six in the following list are made with oil of theobroma:—

**Suppositoria Acidi Carbolici** (Phenol), 1 grain of phenol in each suppository.

„ **Acidi Tannici**, 3 grains tannic acid in each suppository.

„ **Belladonnæ**,  $1\frac{1}{2}$  grains alc. extract in each suppository.

„ **Iodoformi**, 3 grains iodoform in each suppository.

„ **Morphinæ**,  $\frac{1}{4}$  grain hydrochloride in each suppository.

„ **Plumbi Composita**, 3 grains lead acetate and 1 grain opium in each suppository.

„ **Glycerini** contain 70 per cent. of glycerin to which the necessary consistence has been imparted by gelatin.

## Syrupi.

**Syrups.**—The official syrups are solutions or liquors (prepared by infusion, percolation, etc.), of various substances, nearly saturated with refined cane sugar. In making them, care should be taken to accurately adjust the weight or volume of the finished product as directed. If this precaution be neglected, the syrup may be too strong or too weak in sugar; in the former case, some of the sugar will crystallise out on standing, and in the latter the syrup will be liable to ferment. For, although a syrup of the strength indicated in the Pharmacopœia will keep perfectly well under proper conditions, weaker solutions of sugar form a very favourable nutrient medium for the cultivation of moulds and bacteria. The weight of the pan or other vessel in which the syrup is prepared should, therefore, if necessary, be carefully recorded so that the final adjustment may be accomplished without the necessity of transferring its contents to another vessel. The employment of syrups is based chiefly upon three properties exhibited by the sugar which forms their largest component:— (1) It renders more palatable the remedies with which it is combined. (2) The preservation from decomposition of proximate vegetable principles in strong sugar solutions. Weak syrups are without this preservative action, being themselves liable to alcoholic, lactic, butyric, and putrefactive fermentation. (3) The retarding influence exerted by sugar upon many chemical changes, particularly the oxidation of ferrous salts. There are twenty-two official syrups.

### **Syrupus. SYRUP.**

This is commonly known as Simple Syrup, and is a solution of two parts of sugar in one part of water.

### **Syrupus Aromaticus. AROMATIC SYRUP.**

Is a mixture of tincture of orange, cinnamon water, and syrup. The turbidity produced by the addition of the tincture is removed by the addition of talc and filtration. The preparation is used as a flavouring agent.

*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.



**Syrupus Aurantii.** SYRUP OF ORANGE.

A mixture of tincture of orange, 1, with syrup, 7.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Aurantii Floris.** SYRUP OF ORANGE FLOWER.

Sugar, 6 parts, is dissolved in boiling water, 2 parts, and orange-flower water, 1 part, added to this strong syrup. The orange-flower water is added after the sugar is dissolved in order to avoid dissipating its aroma by the prolonged application of heat.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Calcii Lactophosphatis.** SYRUP OF CALCIUM LACTOPHOSPHATE.

Precipitated calcium carbonate is dissolved in diluted lactic acid to form calcium lactate, and phosphoric acid added. Some orange-flower water is then added as a flavouring agent, and sugar dissolved in the liquid without the aid of heat.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Cascaræ Aromaticus.** AROMATIC SYRUP OF CASCARA.

Is a mixture of liquid extract of cascara with tincture of orange, alcohol, cinnamon water, and syrup. It contains 1 of the liquid extract in  $2\frac{1}{2}$  of the finished product, the nauseous, bitter taste of the cascara being to some extent covered by the flavouring agents.

[Dose.— $\frac{1}{2}$  to 2 fluid drachms.]

**Syrupus Chloral.** SYRUP OF CHLORAL.

Chloral hydrate is dissolved in a small quantity (about its own weight) of water and mixed with simple syrup, so that the product contains 10 grains of chloral hydrate in each fluid drachm.

[Dose.— $\frac{1}{2}$  to 2 fluid drachms.]

**Syrupus Codeinæ.** SYRUP OF CODEINE.

Codeine phosphate is dissolved in distilled water (about four times its weight is required) and mixed with sufficient simple syrup, so that each fluid drachm shall contain  $\frac{1}{4}$  grain of codeine phosphate. The phosphate is employed in this syrup because it is much more readily soluble than the free alkaloid.

[Dose.— $\frac{1}{2}$  to 2 fluid drachms.]

**Syrupus Ferri Iodidi.** SYRUP OF FERROUS IODIDE.

Ferrous iodide is first prepared by digesting iodine with an excess of iron wire and a little water in a flask, heating the product finally to boiling, until the whole of the free iodine has combined with the iron. The liquid is then immediately filtered into a previously prepared strong solution of sugar in water, the flask and its contents being rinsed out with a little hot diluted syrup which is poured through the filter, and this is afterwards washed with boiling distilled water to bring the product to the required volume. Ferrous iodide, either solid or in aqueous solution, is very unstable. It rapidly oxidises with formation of a red ferric oxyiodide and free iodine, hence the necessity for freshly preparing the salt as described and filtering its solution at once into the syrup. In presence of sugar its oxidation is much retarded, and if stored in bottles, quite filled and well closed, it may be preserved in good condition for a long period. In the

official formula excess of iron is employed, in order to facilitate the completion of the reaction. The combination of the iodine and iron produces much heat, and the flask should be cooled during the chemical action—if the temperature of the reaction mixture rises sufficiently high to cause the formation of violet vapours of iodine—by holding it in a stream of cold water. The completion of the reaction is shown by the disappearance of the brown colour of the iodine, and this is best observed in the froth, since the liquid contains more or less dark suspended matter consisting chiefly of carbon and other impurities in the iron. The finished syrup should have a specific gravity of 1.380 to 1.387, and contain 1 part of ferrous iodide in 10 fluid parts, equivalent to 1 grain in 11 minims. To verify this requirement remember that an excess of iron is employed, and that the quantity of ferrous iodide formed is, therefore, based upon the quantity of iodine in the formula. Now, 251.80 parts of pure iodine (2I) will produce 307.40 parts ( $\text{FeI}_2$ ) of ferrous iodide, and taking the metric quantities of the official formula

$$83 \text{ grammes of pure iodine will produce } \frac{307.4 \times 83}{251.8} \text{ grammes } \text{FeI}_2 \\ = 101.3 \text{ grammes.}$$

But Iodum B.P. is only required to be 98.7 pure; therefore, on this basis, we should obtain

$$\frac{101.3 \times 98.7}{100} = 100.0 \text{ grammes of ferrous iodide,}$$

and that quantity is contained in 1000 C.c. of finished syrup.

**Test.**—This depends upon the conversion of the iodide into sodium iodide. Ferrous iodide solutions cannot be directly titrated with silver nitrate, for although the reaction between the two bodies resembles that of other iodides—

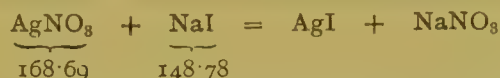


there is no means of indicating the end of the reaction during titration, because potassium chromate forms an insoluble iron chromate when added to the iron solution. The ferrous iodide is therefore converted into insoluble carbonate by reaction with solution of sodium carbonate—



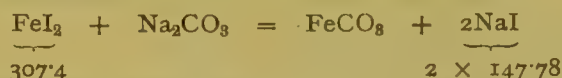
In order to avoid the trouble of washing the bulky iron precipitate so as to collect all the sodium iodide in the filtrate, the method is adopted of diluting the reaction mixture to a measured volume, and then filtering off for titration an aliquot part therefore; 10 C.c. of the syrup are agitated with a solution of 1 gramme of dried sodium carbonate until the reaction is complete, diluted to the volume of 100 C.c., well mixed and filtered; 25 C.c. of this filtrate, as described in the official test, is therefore equivalent to  $2\frac{1}{2}$  C.c. of syrup, and should require between 16 and 16.5 C.c. of N/10 silver nitrate solution for complete precipitation, using

potassium chromate as indicator. Taking the lower limit of volumetric silver nitrate solution, 16 C.c., and according to the equation—



1,000 C.c. N/10 AgNO<sub>3</sub> are equivalent to  $\frac{148.78}{10}$  grammes, NaI

but by the equation—



this quantity of sodium iodide is also equivalent to

$\frac{307.4}{2 \times 10}$  grammes of ferrous iodide.

∴ 1,000 C.c. N/10 AgNO<sub>3</sub> are equivalent to  $\frac{307.4}{20}$  grammes FeI<sub>2</sub>.

∴ 1 C.c.                    "                    indicates  $\frac{0.3074}{20}$                     "                    "

and 16 C.c.                "                    "                     $\frac{0.3074 \times 16}{20}$                     "                    "  
= 0.246 gramme.

By the same method of calculation the higher limit, 16.5 C.c., will indicate 0.254 grammes FeI<sub>2</sub> in 2.5 C.c. of syrup, or an average of 1 part in 10 by volume. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

### Syrupus Ferri Phosphatis. SYRUP OF FERROUS PHOSPHATE.

Iron wire is dissolved in concentrated phosphoric acid diluted with an equal bulk of water, by the aid of a gentle heat. Hydrogen is evolved and ferrous phosphate formed. This salt is insoluble in water, but dissolves in presence of the excess of phosphoric acid employed in the official process.



When cold, the acid solution of ferrous phosphate is filtered (to remove insoluble impurities from the iron) into syrup, the flask and filter being washed with water to remove adherent solution, and make the product up to the required bulk. The syrup should contain 1 grain of anhydrous ferrous phosphate in 1 fluid drachm. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

### Syrupus Ferri Phosphatis cum Quinina et Strychnina. SYRUP OF PHOSPHATE OF IRON WITH QUININE AND STRYCHNINE.

An acid solution of ferrous phosphate is prepared, and in this is dissolved quinine sulphate and strychnine, the mixture being filtered into syrup and finished off as for the simple ferrous phosphate syrup. It should contain in each fluid drachm the equivalent of 1 grain of ferrous phosphate,  $\frac{1}{2}$  grain of quinine sulphate, and  $\frac{1}{32}$  grain of strychnine. This combination is usually known as Easton's syrup, although the official formula differs in many points from the original formula of Easton, which included the preparation of ferrous phosphate from ferrous sulphate and sodium phosphate. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]



**Syrupus Glucosi.** SYRUP OF GLUCOSE.

A mixture of 1 part, by weight, of commercial liquid glucose and 2 parts, by weight, of simple syrup. It forms a useful pill excipient; pill-masses made with it do not harden and become crumbly so quickly as those made with simple syrup alone, owing to the uncrystallisable nature of the glucose, and the pills are also not so hygroscopic as those made with excipients containing glycerin.

**Syrupus Hemidesmi.** SYRUP OF HEMIDESMUS.

Hemidesmus root is infused in boiling water for four hours, the clear infusion decanted, sugar added to it and dissolved by the aid of a gentle heat.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Limonis.** SYRUP OF LEMON.

A tincture is prepared from fresh lemon peel by maceration in 90 per cent. alcohol. Sugar is then dissolved in freshly expressed lemon juice, clarified by subsidence, and to this, when cold, the previously prepared tincture of lemon peel is added.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Pruni Virginianæ.** SYRUP OF WILD CHERRY.

Wild cherry bark, in powder, is moistened with water and macerated twenty-four hours. It is then percolated with water, sugar dissolved in the percolate and some glycerin added. During the maceration the glucoside (which closely resembles if it is not identical with amygdalin) present in the bark is decomposed and the percolate will contain the essential oil and hydrocyanic acid resulting therefrom. In order to avoid loss of those principles, the sugar is dissolved in the percolate without the employment of heat.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Rhei.** SYRUP OF RHUBARB.

A mixture of rhubarb root and coriander fruit, in powder, is moistened and percolated slowly with a weak alcoholic menstruum (90 per cent. alcohol 1 part, water 3 parts). The percolate is concentrated by evaporation, filtered, sugar added to the filtrate and dissolved by the aid of gentle heat.

[Dose.— $\frac{1}{2}$  to 2 fluid drachms.]

**Syrupus Rhæados.** SYRUP OF RED POPPY.

A strong infusion of fresh red poppy petals is made with hot water. The liquor is expressed from the bulky marc, filtered, and sugar dissolved in it. When nearly cold some 90 per cent. alcohol is added, as the syrup is very liable to ferment and become mouldy.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Rosæ.** SYRUP OF ROSES.

Dried red rose petals are infused in boiling water, the infusion filtered, and sugar dissolved in the filtrate.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Scillæ.** SYRUP OF SQUILL.

Sugar is dissolved in vinegar of squill.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Syrupus Sennæ.** SYRUP OF SENNA.

Senna is macerated with three successive portions of 20 per cent. alcohol and strongly expressed after each period of maceration. The first two expressed liquids are set aside, the third being concentrated by evaporation and mixed with the reserved portions. This method is adopted in order to avoid risk of injury by the prolonged application of heat to the stronger liquids previously expressed. The mixed liquids are heated to 82° C., which causes the separation of an albuminous coagulum, and then set aside for this to deposit. Sugar is dissolved in the filtrate by the aid of gentle heat, and then a little oil of coriander, dissolved in alcohol, is added to flavour the product. The separation of albumin coagulable by heat as described above is very commonly carried out in pharmaceutical preparations, since bodies of that class are inert medicinally and their presence in the fluids renders them more prone to putrefactive decomposition. Proteids, of which this coagulable vegetable albumin is an example, form very favourable nutrient media for the development of moulds and bacteria. 20 per cent. alcohol is used instead of water in making syrup of senna, because when made with the latter menstruum the syrup often fermented, the sugar alone being, in this case, insufficient to prevent the development of organisms in the finished syrup. [Dose.— $\frac{1}{2}$  to 2 fluid drachms

**Syrupus Tolutanus.**—SYRUP OF BALSAM OF TOLU.

Balsam of Tolu is boiled for half-an-hour with water, the quantity lost by evaporation being replaced at the end of the period. The hot liquid is set aside to cool, the insoluble resin forming a cake in the bottom of the vessel, while a deposit of white scaly crystals of cinnamic acid also forms as the liquid cools, owing to the greater solubility of that substance in hot water. The cold liquid is filtered and sugar dissolved in the filtrate. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Syrupus Zingiberis.** SYRUP OF GINGER.

Ginger, in fine powder, one part, is percolated with 90 per cent. alcohol to produce two fluid parts of percolate, and one part of this strong tincture is diluted with simple syrup to 20 parts.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm

**Tabellæ Nitroglycerini.**

Trinitrin or Nitroglycerin Tablets should each contain 1/100 grain of trinitroglycerin, and weigh 5 grains. They may be made by pouring the required quantity of the official solution of nitroglycerin upon chocolate powder, carefully and thoroughly stirring, and then massing with an ordinary pill excipient. After adjusting the weight of the mass by the addition of chocolate powder, it may be cut up into portions of the required weight.

[Dose.—1 or 2 tablets.

**Tamarindus.**

Tamarinds are the fruits of *Tamarindus indica*, Linné (N.O. Leguminosæ), which is indigenous to Tropical Africa, and cultivated in the West and East

Indies. The fruit has a rough, brittle, brownish shell or epicarp, which is easily separated, and reveals the mesocarp as a juicy acid pulp, traversed by a number of stout branching fibro-vascular bundles, passing from the stalk towards the apex of the legume. The endocarp is a tough, leathery membrane, which encloses the polished brown, flattened, four-sided seeds in separate cells. The fruits, freed from the brittle epicarp and preserved with sugar, are official. They are chiefly imported from the West Indies, where they are prepared by collecting them when ripe, removing the epicarps, packing the rest of the fruits in layers in barrels, and pouring hot syrup over them as a preservative; or, the prepared fruits may be packed in stone jars, with alternate layers of powdered sugar. In the East Indies tamarinds are sometimes packed as in the West Indies, but they are more frequently prepared for market by simply stripping off the epicarps and pressing the pulpy mass into firm black cakes, which are not official.

**Characters and Tests.**—Tamarinds are usually seen as a reddish-brown, moist, sugary mass, containing strong branched fibres (fibro-vascular bundles), and shining, reddish-brown seeds enclosed in cells formed by the tough membranous endocarp. The pulp has an agreeable odour, and a slightly acid, refreshing taste. If the pulp should have been prepared in copper vessels traces of that metal may be present in tamarinds, and will form a reddish deposit upon a piece of bright iron left for thirty minutes in contact with the pulp, after diluting the latter somewhat with water; the presence of copper will also be indicated on applying the usual tests for that metal.

**Notes.**—East Indian tamarinds, preserved without sugar, are usually in cakes; they have a strongly acid taste but scarcely any odour. West Indian tamarinds contain much added sugar, and proportionately less acid. Tamarind pulp contains about 10 per cent. of free tartaric acid, about 8 per cent. of acid potassium tartrate, and from 25 to 40 per cent. of invert sugar. The total acidity of the pulp is from 11 to 16 per cent.

## Taraxaci Radix.

**Taraxacum Root** is obtained from the common dandelion, *Taraxacum officinale*, Wiggers (N.O. Compositæ), a herbaceous plant, which is widely distributed throughout Europe, Asia and North America. All parts of the plant contain a somewhat bitter, milky juice (latex) in vessels which are arranged in a reticulate manner (anastomosed), but the root is the only part of the plant used for medicinal purposes. It is perennial, tapering, and passes imperceptibly, towards its upper part, into a rootstock or erect rhizome, which may be simple or branched. The root is traversed vertically by ten to twenty concentric rings of anastomosing laticiferous vessels, and is supposed to be most active in the autumn, at which season of the year it is, therefore, directed to be collected. It is a mild laxative and bitter tonic, and is used both in the fresh and dried states, the fresh root being used in the preparation of the extract and juice, while the dried root is used in preparing the liquid extract.



**Characters.**—*Taraxacum* root frequently attains a length of 30 Cm. or more, and a diameter of 12 Mm. or more. When fresh, it is smooth and yellowish-brown externally, whitish and fleshy within, and breaks readily with a short fracture; a bitter, milky juice (latex) exudes from the fractured surface and, on careful examination of a transverse section, can be seen to proceed from faint concentric rings of tissue in which the anastomosing laticiferous vessels are situated. The dried root is dark brown or nearly black, more or less shrivelled, deeply wrinkled longitudinally, tapers but little at its lower extremity, and is often divided into several branches at the opposite extremity, where the root merges into the rootstock; the branches or the rootstock itself may be crowned with the short remains of leaves, near the point of insertion of which brownish hairs can be detected. The fracture of the dried root is short and the fractured surface, like that of the fresh root, shows a small yellow, porous, central wood, surrounded by a very thick, whitish bark or cortex, in which numerous irregular, brownish, concentric rings of laticiferous tissue are visible. The dried root is hygroscopic, and becomes tough when slightly moist. Neither the fresh nor dried root has any odour, but the drug possesses a bitter taste, which is due to the presence of taraxacin.

**Notes.**—Though *taraxacum* root contains no starch, early in the spring it contains much uncrystallisable sugar, which diminishes in quantity during the summer and becomes replaced in the autumn by inulin, a substance resembling starch, of which the root may contain as much as 24 per cent. In the fresh root the inulin present is dissolved in the cell-sap, but in the dry root it occurs as an amorphous, transparent solid, which is only slightly soluble in cold water; it is coloured yellow by iodine, and is converted into levulose when heated with dilute acids, or with water under pressure. The active principle of the drug, however, is a crystalline, bitter substance named taraxacin, of which the yield varies in roots collected at different seasons; it is soluble in water or alcohol, and decomposes very readily. A second crystalline principle, named taraxacerin, is a wax-like body which is insoluble in water but soluble in alcohol, the solution having an acrid taste. The drug also contains pectin, resin, and sometimes levulin, a substance resembling dextrin and having a similar composition to inulin, but very soluble in water, and devoid of rotatory power. Pectin is formed from pectose, a product of the metamorphosis of the substance constituting the cell membrane, of which the intra-cellular substance of the root is understood to consist chiefly. Mannite has been found in an infusion of *taraxacum*, but does not pre-exist in the root; it appears to be formed by changes consequent on exposure. Pellitory root (*Anacyclus Pyrethrum*) differs from *taraxacum* root in having oil glands and a large radiate wood with conspicuous medullary rays; liquorice root also has a large radiate wood.

## Terebenum.

**Terebene** is a preparation of complex and somewhat variable composition, officially described as a mixture of dipentene and other hydrocarbons, obtained by

agitating the oil of turpentine with successive quantities of sulphuric acid until it is optically inactive, and then distilling in a current of steam. It would be better described as a mixture of polymerides and isomerides of the empirical formula,  $C_{10}H_{16}$ , together with small quantities of oxidation products, formed by the action of sulphuric acid on oil of turpentine. Terebene may be prepared from either French or American oil of turpentine, but it is doubtful if an optically inactive product can be obtained from the latter.

**Characters and Tests.**—Terebene is described as a colourless optically inactive liquid (specific gravity 0·862 to 0·866), having an agreeable odour and an aromatic terebinthinate taste. It should be soluble in alcohol, ether, glacial acetic acid, or carbon bisulphide, but only slightly soluble in water. It is also officially stated that it should distil between  $156^{\circ}$  and  $180^{\circ}$  C., not more than 15 per cent. distilling below  $165^{\circ}$  C., and that only a slight viscid residue should be left, the absence of excess of resin being thus indicated. The absence of acids is indicated by the colour of moistened blue litmus paper remaining unaltered.

**Notes.**—Though it is possible to obtain terebene which is optically inactive, it may acquire optical activity on keeping, and is usually either slightly dextro-rotatory or lævo-rotatory when prepared, as it generally is, from American oil of turpentine. The specific gravity of terebene may be as low as 0·855, but increases with the age of the oil from which it is distilled; it also appears probable that the tendency towards lævo-rotation and a high boiling point increases with the age of the turpentine from which the terebene is prepared. The composition of terebene necessarily varies with the constituents of the oil from which it is prepared. Oil of turpentine consists chiefly of dextro-pinene and lævo-pinene, but may also contain camphene, fenchene, and traces of formic, acetic, camphoric, and resin acids; camphoric aldehyde, to which the peculiar odour of “rancid” oil of turpentine is due, may also be present, whilst dipentene and polymeric terpenes occur as the result of the action of the acids in the oil on the pinene present. Terebene has been shown to consist chiefly of dipentene and terpinene, with some cymene (cymol) and camphene. Dipentene is the optically inactive modification of limonene. As already stated, it is a common constituent of oil of turpentine, being formed by the isomerisation of pinene; by the action of heat it yields polymers, but if alcoholic sulphuric acid be present it is converted into terpinene. The latter hydrocarbon is also formed together with isomeric hydrocarbons and cymene,  $C_{10}H_{14}$ , by the inversion of pinene with alcoholic sulphuric acid, or when oil of turpentine is shaken with small quantities of sulphuric acid. Both terpinene and cymene are pleasant smelling liquids; the former resinifies rapidly on standing, whereas cymene becomes turbid, with separation of water. Camphene is the only hydrocarbon of the formula  $C_{10}H_{16}$  known to assume the solid form; it is a natural constituent of oil of turpentine, but can also be produced artificially in various ways, being most readily prepared from isoborneol by the abstraction of water with zinc chloride. It has a faint camphor-like odour and is much more stable than other terpenes.

[Dose.—5 to 15 minims.]



## Terebinthina Canadensis.

**Canada Turpentine** or "**Balsam**" is the oleo-resin obtained from the balsam fir, *Abies balsamea*, Miller (N.O. Coniferæ), a native of Canada, Nova Scotia, and the Northern and North-Western United States. The bark of the tree contains schizogenous ducts in which the oleo-resin is secreted, and, as the liquid accumulates, pustules or swellings are formed on the trunk and larger branches. The oleo-resin is collected by puncturing the pustules with the pointed lip or spout of a small iron can, into which it slowly exudes. It is collected chiefly in the province of Quebec, and may also be obtained from the hemlock spruce, *A. canadensis*, Miller.

**Characters and Tests.**—Canada turpentine is a pale yellow transparent oleo-resin of the consistence of thin honey, and it often exhibits a slight greenish fluorescence. It becomes more viscid on keeping, and on exposure to the air gradually dries to a hard, transparent, varnish-like resin, which shows no signs of granular or crystalline structure. It is soluble in benzene, chloroform, ether, oil of turpentine, etc., and partially soluble in alcohol. The oleo-resin is dextro-rotatory, though it contains a lævo-rotatory volatile oil, to which its peculiar, but agreeable, terebinthinate odour is due; the slightly bitter and feebly acrid taste is due to a bitter principle and resin. When mixed with about one-sixth its weight of magnesia, moistened with a little water, the oleo-resin gradually solidifies, thus showing the absence of other turpentine. As the solidification depends simply upon the formation of magnesium salts of the resin acids, it will occur in the case of all coniferous resins.

**Notes.**—The freedom from crystallisation of Canada turpentine renders it particularly useful as a medium for preserving microscopical preparations, for which purpose the oleo-resin is usually heated until it ceases to lose weight, and the residue, after cooling, dissolved in benzene, oil of turpentine, xylol, or other suitable solvent. An additional advantage in this connection is that the refractive index of the turpentine (1.532) is nearly the same as that of crown glass, so that but little refraction takes place when the rays of light pass from the glass slide to the mounting medium, or from the medium to the thin glass cover. The chief constituents of Canada turpentine are volatile oil and resin, rather more than half of the latter being soluble in alcohol, while the remainder is sparingly soluble; other constituents are a caoutchouc-like substance resembling the resin soluble in alcohol, a bitter principle which is soluble in water, and traces of acetic and succinic acids. The oleo-resin has been shown to contain from 16 to 24 per cent. of volatile oil mixed with 70 to 80 per cent. of resin. The resin contains about 20 per cent. each of canadinic acid and an indifferent resene (canado-resene) which is remarkable for its insolubility in alcohol, the remaining 60 per cent. consisting of two amorphous resin acids,  $\alpha$ - and  $\beta$ -canadinolic acid. The volatile oil (b.p. 160° to 167° C.) consists chiefly of lævo-pinene, but it is also stated to contain bornyl acetate and borneol. The term "balsam" is incorrectly applied to Canada turpentine, as it should strictly be limited to oleo-resins which contain or yield benzoic or cinnamic acid.



## Thus Americanum.

**Frankincense** is a solidified oleo-resin found as a yellowish-white incrustation on the trunks of *Pinus palustris*, Miller (N.O. Coniferæ), and *P. Tæda*, Linné. It consists of the last portions of the crude turpentine (*vide* Oleum Terebinthinæ) which flows from incisions made in the spring. The concrete oleo-resin is removed by scraping, and exported under the name of "American" or "common" frankincense, being also known as "Gum Thus."

**Characters.**—Frankincense occurs when fresh as a rather soft, pale yellow, opaque, tough solid, with a terebinthinate odour. It becomes hard on keeping, however, and is usually seen in darker yellow, dry, brittle, translucent masses, with only a faint odour.

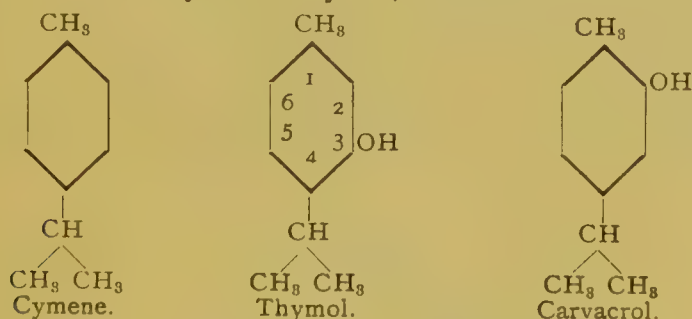
**Notes.**—Common frankincense must not be confused with olibanum or true frankincense, obtained from *Boswellia carterii*, Birdwood (N.O. Burseraceæ), and other species of *Boswellia*, which grow in Southern Arabia and Somaliland. Olibanum occurs in pale yellow, brittle tears of varying shape, from 6 to 25 Mm. long, covered with whitish dust externally, opalescent and waxy internally; it softens when chewed, has a fragrant balsamic odour and a slightly bitter aromatic taste, and yields a whitish emulsion when triturated with water. It consists chiefly of a resin acid (boswellic acid)—partly free and partly combined as an ester—and indifferent resins (olibanoresenes); other constituents are a bitter principle, 27 to 35 per cent. of gum, mainly arabin, with a little bassorin, and 3 to 8 per cent. of volatile oil, which consists for the greater part of three terpenes—lævo-pinene (olibene), dipentene, and phellandrene. Common frankincense, on the other hand, contains no gum, and consists chiefly of  $\alpha$ ,  $\beta$ , and  $\gamma$  abietic acids, which cause it to exhibit a crystalline structure when examined under the microscope; it also contains a resene, a small quantity of oil of turpentine, and traces of a bitter principle, its composition according with that of colophony resin (*vide* Resina).

## Thymol.

**Thymol** is a crystalline phenol—isopropyl-meta-cresol,  $C_6H_8 \cdot CH_3 \cdot OH \cdot C_8H_7$ —obtained from the volatile oils of *Thymus vulgaris*, Linné (N.O. Labiatæ), *Monarda punctata*, Linné (N.O. Labiatæ), *Carum copticum* (*C. Ajowan*), Bentham and Hooker filius (N.O. Umbelliferæ), and other plants. It is also known as thyme camphor. Occasionally thymol crystallises from old oils when cooled, but it can only be removed completely by shaking with caustic alkali. It may be obtained by distilling off the greater part of the hydrocarbons present in the oils, then adding to the residue a solution of sodium hydroxide; the alkali combines with the phenol to form a soluble phenate, and, after hot water has been added to cause any uncombined oil to separate, hydrochloric acid is added to the alkaline solution to liberate the thymol, which collects as an oily layer. After separation and cooling, the oily liquor is caused to crystallise by the addition of a crystal of thymol.

**Characters and Tests.**—Thymol occurs in large, colourless, oblique prismatic crystals (m.p.  $44^{\circ}$  to  $51^{\circ}$  C.), which have the odour of thyme and a pungent aromatic taste. The crystals sink in cold water, but melt on heating the mixture above  $44^{\circ}$  C., rising to the surface as an oily layer; they volatilise completely at the temperature of a water bath, the absence of paraffin, spermaceti, etc., being thus indicated. The crystals are almost insoluble in cold water (solubility, 1 in 1500), freely soluble in 90 p. c. alcohol (8 in 3), ether (8 in 5) or solutions of alkalis; they are also more or less soluble in chloroform, petroleum ether, oil of turpentine, olive oil, glacial acetic acid, and glycerin. A solution of thymol in half its bulk of glacial acetic acid assumes a reddish-violet colour when warmed with an equal volume of sulphuric acid (specific gravity, 1.843). If a small crystal of thymol be dissolved in 1 C.c. of glacial acetic acid, the solution will assume a deep bluish-green colour on adding 6 drops of sulphuric acid and 1 drop of nitric acid. The absence of lævo-pinene (thymene) is shown by a clear, colourless or very slightly reddish solution being formed on heating—in a water bath—1 Gm. of thymol with 5 C.c. of 10 per cent. sodium hydroxide solution contained in a test-tube; the solution becomes darker on standing, and a violet colour is produced on adding a few drops of chloroform and agitating the mixture, but no oily drops separate if lævo-pinene be absent.

**Notes.**—As already stated, thymol is a phenol—*i.e.*, it contains a hydroxyl group substituting one of the hydrogen atoms of the benzene nucleus. The formula given in the Pharmacopœia shows that it contains three substituting groups (OH), ( $\text{CH}_3$ ), and ( $\text{C}_3\text{H}_7$ ), but does not indicate the relative positions of those groups in the benzene nucleus. It should be noted, therefore, that the official formula applies equally well to an isomer of thymol—carvacrol (isopropyl-ortho-cresol), another constituent of oil of thyme and other volatile oils. Carvacrol and thymol are phenols,  $\text{C}_{10}\text{H}_{14}\text{O}$ , derived from cymene or methyl-isopropylbenzene,  $\text{C}_{10}\text{H}_{14}$ , the prefix *iso-*, indicating that the  $\text{C}_3\text{H}_7$  group is not the normal propyl group,  $\text{CH}_2\text{—CH}_2\text{—CH}_3$ , but the isomeric group— $\text{CH} \begin{cases} \text{CH}_3 \\ \text{CH}_3 \end{cases}$ . The graphic formulæ for cymene, thymol, and carvacrol are given here for



comparison, and it will be noted that the relative position of the hydroxyl group differs in the formulæ of the two phenols. The difference in the constitution of the two phenols may also be shown by numbering the positions occupied by the substituting groups. Thus, thymol is isopropyl-meta-cresol,  $\text{C}_6\text{H}_3\text{:CH}_3^{[1]}\text{:OH}^{[6]}\text{:C}_3\text{H}_7^{[4]}$ , or methyl-1-isopropyl-4-oxy-3-benzene, whilst carvacrol is isopropyl-ortho-cresol,  $\text{C}_6\text{H}_3\text{:CH}_3^{[1]}\text{:OH}^{[2]}\text{:C}_3\text{H}_7^{[4]}$ , or

methyl-1-isopropyl-4-oxy-2-benzene. The chief rule for the arrangement of the numbers or indices is to give the index (1) to that substituting group in which the element directly connected with the nucleus has the lowest atomic weight. If two or more of the groups contain the same element directly bound to the nucleus (as in the present case,  $\text{CH}_3$  and  $\text{C}_3\text{H}_7$ ) then the index (1) is given to that group in which the sum of the atomic weights of the remaining elements is least. Since thymol is a phenol, it dissolves in aqueous solutions of potassium and sodium hydroxides to form soluble phenates. That property is utilised to separate thymol from the other non-phenol constituents of volatile oils which contain it. The oil is shaken with caustic lye, and that, after separation from the oil, is washed and acidulated with hydrochloric acid. The acid liberates the thymol, which is precipitated. Thymol is a powerful antiseptic and, as it is much less caustic and irritating than many other antiseptic substances, finds extensive use as a preservative. In the oil of *Thymus vulgaris* the amount of phenols—thymol and carvacrol—present is usually from 20 to 30 per cent., though as much as 42 per cent. has been found. As a rule, the thymol is present in larger proportion than carvacrol, and it is also associated with a third phenol, together with cymene, lævo-pinene, borneol, linalool, and bornyl acetate. The oil of *Monarda punctata* contains 61 per cent. of thymol, also carvacrol, cymene, and dextro-limonene (citrene). Ajowan oil, from *Carum copticum* (*C. Ajowan*), contains 45 to 55 per cent. of thymol, also cymene and a second terpene, a mixture of the two hydrocarbons being known in commerce as "thymene." Thymol can be formed artificially from menthone, a keytone found in oil of peppermint and other oils. It can also be prepared from para-cymene,  $\text{C}_{10}\text{H}_{14}$ , a hydrocarbon which occurs in the oils from which thymol is obtained; it is worthy of note that camphor, citral, and several other compounds having the formula  $\text{C}_{10}\text{H}_{16}\text{O}$  can be converted into para-cymene by the abstraction of water. [Dose.— $\frac{1}{2}$  to 2 grains.]

## Thyroideum Siccum.

**Dry Thyroid** is a powder prepared from the fresh and healthy thyroid gland of the sheep, *Ovis aries* (Order Ungulata). The gland consists of two lobes which lie closely applied to the windpipe (trachea), one on each side, and are easily distinguished from the surrounding tissues by their dark-red colour. Their upper extremities are connected by a bridge of tissue, which crosses the trachea, but is often so thin or pale-coloured as to be difficult to detect. The gland is most conveniently removed by cutting out the two lobes separately, without the connecting bridge of tissue, directly after the animal is killed. When free from all external fat and connective tissue the lobes are of a broadly almond-shape, and should consist of a firm, succulent mass of tissue. If, when cut across, they appear hypertrophied, or contain cysts, or are otherwise abnormal, they must be rejected. The healthy glands are thinly sliced and minced or pounded, then dried as rapidly as possible in a current of warm air, the pounded mass being spread in a thin layer to dry and the temperature not exceeding  $32^\circ$  to  $38^\circ \text{C.}$ , though a higher temperature is not likely to prove harmful, since the active constituent of the glands is not readily affected by



heat. It is important to remove the bulk of the moisture in the glands as quickly as possible, and the mass is preferably dried in a vacuum. When sufficiently dry, the thyroid should be coarsely powdered, all fat removed from the product by treatment with petroleum ether, and the powder finally dried completely by spreading it in a thin layer and leaving it in a desiccator for a day or two. The fat is removed in order to prevent rancidity, but that stage in the process is unnecessary if the thyroid be thoroughly dried in a desiccator directly after being powdered, and subsequently preserved in such a way as to avoid hygroscopic influences.

**Characters.**—Dry thyroid is a light dull-brown powder, with a very faint meat-like odour and taste, but free from any trace of putrescence. It absorbs moisture and deteriorates on exposure to the air.

**Notes.**—The thyroid gland of the sheep is used for medicinal purposes because it is the one most easily obtainable. The sheep's gland is also the one with which most of the clinical as well as experimental work was done when the thyroid was first introduced as a medicinal agent. More is known, therefore, about the physiological action and dosage of sheep's thyroid, although the glands of other animals have also been occasionally employed. Thyroidin, iodothyryn, thyro-antitoxin, iodo-globulin, thyroglobulin, and thyroglandin are preparations which have been claimed to be, or to contain, the active principle of the thyroid gland, but the most that is known at present about the active principle is that it contains iodine, is very resistant to heat, and it is soluble in water or in diluted glycerin. On acidifying solutions containing it with phosphoric acid and then neutralising the liquid with lime water, the precipitate of calcium phosphate formed carries down with it the active constituent of the gland. The precipitate contains iodine, and produces the same effects as dry thyroid. Thyroglandin is prepared by macerating the prepared glands in cold water and evaporating the solution to dryness, the powdered extract thus obtained representing the iodo-globulin, and a small proportion of saline matter. The residue of the glands is then boiled for an hour with dilute sodium hydroxide solution, and, after cooling and removal of fat, the liquid is neutralised with hydrochloric acid, and evaporated to dryness; the residue, which contains all the thyroidin, is then powdered and mixed with the iodo-globulin powder to form thyroglandin. The name "thyroglobulin" has been applied to an albuminoid body stated to exist in the thyroid; it is said to contain the whole of the iodine present in the glands, in combination, and is claimed to be the active constituent of the thyroid.

[Dose.—3 to 10 grains..

## Tincturæ.

**Tinctures** constitute a large and important class of preparations, the extensive employment of which in medicine is chiefly due, first, to their permanence, owing to the preservative properties of alcohol, and secondly, to the facility with which alcohol exhausts certain drugs, such as guaiacum, benzoin, Indian hemp, etc. Subsidiary reasons are to be found in the attractive appearance of tinctures, which can usually be filtered perfectly bright, since alcohol coagulates, and does not extract, albuminous and gummy sub-

stances, which form the chief obstacle to the clarification of preparations like infusions and decoctions. Moreover, the medicinal action of many carminative and tonic remedies like ginger, calumba, and cinchona is considered to be distinctly promoted by the association of their active principles with alcohol. Proof and rectified spirits were formerly the two strengths of alcohol employed almost exclusively in the official formulæ. There is no doubt that many drugs are exhausted better by alcohol of other strengths than those, and in some cases equally well and more economically by weaker alcohol than that of proof strength. In the present edition of the British Pharmacopœia (1898) changes in this direction are found, based upon work which has mainly been done since the publication of the 1885 edition. There are sixty-seven tinctures official in the British Pharmacopœia 1898, and their description will be facilitated by discussing the formulæ under the following headings:— (a) Processes of manufacture; (b) Relative proportions of drug and menstruum employed; (c) Alcoholic strength of menstruum employed; (d) Dosage.

#### (A) PROCESSES OF MANUFACTURE.

Though tinctures may be described broadly as preparations obtained by treating crude drugs with alcohol, so as to extract and obtain in the form of an alcoholic solution the constituents of the drug soluble in that menstruum, there are a number of tinctures which do not conform strictly to that definition, and they will be considered under the heading (3). The processes most frequently employed are (1) maceration and (2) percolation.

(1) **Tinctures made by a Process of Maceration.**—The general process of maceration, applicable to many of the tinctures with no variation beyond the proportionate quantity of drug and alcohol, is given in the Pharmacopœia Appendix, page 440. The directions are:—"Place the solid materials in the whole of menstruum in a closed vessel for seven days, frequently agitating. Strain. Press the marc. Mix the expressed liquid with the strained liquid. Filter if necessary." The prolonged maceration of seven days is enjoined in order to ensure the solution and extraction of all that is soluble, although in some cases this may be accomplished in less time. The directions as to frequent agitation should be attended to strictly, otherwise the absorbed fluid and the layer of menstruum immediately in contact with the particles of the drug will become saturated with the soluble matters, by which their extraction is hindered. This is the more necessary since the drug settles to the bottom of the fluid and, unless the mixture be agitated, the upper layers of alcohol will not gain access to the deposit. Since alcohol is very volatile, the vessel in which the process is conducted should be well closed, otherwise the residual fluid will become more or less concentrated by evaporation and, consequently, of increased but variable potency, depending upon the opportunities which have been afforded for evaporation. At the end of the period of maceration the fluid is decanted and the marc expressed. The united liquors so obtained constitute, without further treatment, the finished tincture, and dilution to a uniform fixed volume is not directed as in the maceration process of the 1885 B.P. At first sight this omission may not appear to lead to uniformity in the products, but a little consideration will show that whereas

the 1885 process produced a uniform volume of tincture of variable potency, the new process leads to a variable volume of tincture of uniform potency. Thus, if 4 ounces of a drug be macerated in 20 fluid ounces of alcohol for seven days, with frequent agitation, it may reasonably be assumed that, at the end of the period of maceration, all the soluble constituents of the drug will have been dissolved and distributed uniformly by diffusion throughout the bulk of the menstruum. Both the supernatant fluid and that absorbed by the tissues of the drug will have attained a condition of equilibrium so far as the distribution of the extractible constituents of the drug are concerned. Neglecting the minor sources of loss, let it be assumed that, by decantation and expression in an ordinary small screw press, 18 fluid ounces of tincture are obtained from the 20 fluid ounces of alcohol taken originally. Then it follows that the pressed marc has retained 2 fluid ounces of tincture, representing a tenth part of the soluble constituents of the 4 ounces of drug. Operating now on larger quantities of the same materials—say twenty times the quantity—and employing the more powerful pressure obtainable by means of a hydraulic press, it would be found that a larger proportionate volume of tincture could be obtained. It may be assumed for the purpose of argument that owing to the more efficient press available and the smaller proportionate loss from other sources in working on large quantities, 19 fluid ounces of tincture would be obtained from each 20 fluid ounces of alcohol, thus leaving only one-twentieth part of the extractible constituents behind. For the reasons already given, the strength of the finished tinctures would be the same in both cases, since the decanted liquid, the expressed liquid, and the liquid imbibed by the drug and not recovered by expression, would all possess the same concentration, *i.e.*, contain the same proportion of dissolved matter, although a larger proportionate quantity of expressed fluid would be obtained in working larger quantities. If now the method of dilution to a definite volume, according to the 1885 Pharmacopœia, were carried out, it would be necessary, in the first case, to add 2 fluid ounces of alcohol to every 18 fluid ounces of tincture, but in the second case only 1 to 19, leading thus to a variation in the strength of the finished tincture, corresponding to the dilution necessary to bring the two different volumes of fluid to a uniform volume. It should, therefore, be apparent that the maceration process now official is much superior to its predecessor. The following nineteen tinctures are prepared by maceration:—

## TINCTURA AURANTII.

- „ CALUMBÆ.
- „ CANTHARIDIS.
- „ CAPSICI.
- „ CARDAMOMI COMPOSITA.
- „ CATECHU.
- „ COCCI.
- „ CROCI.
- „ GENTIANÆ COMPOSITA.

## TINCTURA LAVANDULÆ COMPOSITA.

- „ LIMONIS.
- „ LUPULI.
- „ OPII.
- „ PRUNI VIRGINIANÆ.
- „ QUASSIÆ.
- „ SCILLÆ.
- „ SENNÆ COMPOSITA.
- „ SUMBUL.

## TINCTURA VALERIANÆ AMMONIATA.



In addition to the foregoing, the following seven tinctures are prepared by a process of simple maceration, which differs somewhat from the general maceration process given in the Appendix :—

TINCTURA ALOES.	TINCTURA GUAIACI AMMONIATA.
„ ASAFETIDÆ.	„ KINO.
„ BENZOINI COMPOSITA.	„ MYRRHÆ.
TINCTURA TOLUTANA.	

In the case of these tinctures the drugs are macerated with the alcohol with frequent agitation until dissolved, or for a period up to seven days. The liquid is then filtered and the residue on the filter washed with more alcohol, to remove the adherent fluid containing soluble materials, until a given volume of filtrate is obtained. This difference in final treatment is due to the nature of the drugs from which these seven tinctures are prepared. It will be observed that they are in all cases resinous or gum-resinous bodies, containing no organised tissue elements. Any portion which remains undissolved after treatment with alcohol is therefore sticky and amorphous, and the adherent fluid could not be extracted from it satisfactorily by pressure.

(2) **Tinctures made by a Process of Percolation.**—The general process of percolation applicable to tinctures is given in the Pharmacopœia Appendix, page 440. The powdered drug is to be uniformly moistened with sufficient of the menstruum to convert it into a damp powder, the quantity required in each case being indicated in the formula for that tincture. It is then allowed to stand for twenty-four hours in a closed vessel in order that the tissues may swell before the percolator is packed. If the dry drug be packed in the percolator it often happens that the swelling, which occurs when the fluid is poured on, is so considerable that the contents of the percolator become too tightly wedged and the passage of fluid is rendered impossible. The preliminary soaking also enables the menstruum to permeate the cells, rendering the brittle, dry tissue more pliable, and, therefore, more easily packed uniformly in the percolator. At the same time the cell contents are brought into a plastic condition, so that the soluble constituents are more readily extracted by the subsequent percolation with more of the menstruum. “Pack the mixture in a percolator; lightly, closely, or otherwise, according to the nature of the materials.” The proper packing of the percolator is an operation which can only be learnt by experience. The main points to observe are (1) that the material be uniformly distributed, so as to avoid the formation of channels; (2) that the tightness of the packing should be varied for each material, so that, working on a few pints of tincture, a rapid succession of drops, but not a continuous stream, of percolate should be obtained when the menstruum is poured on. With larger quantities, of course, a proportionately larger flow is permissible. To quote the official directions again, it is necessary next to “pour over the contents, at intervals, further portions of the menstruum, always maintaining a layer of liquid above the materials.” The last point is important, because, if the liquid be allowed to drain away below the surface of the materials, air spaces will be formed in the upper part, so that the succeeding portion of menstruum added will immediately run into and fill up

these without passing slowly through the overlying material. Now, "allow percolation to proceed, slowly at first and afterwards less slowly, until a sufficient quantity of menstruum has been used to produce about three-fourths of the finished tincture, or until exhaustion of the solid materials has been effected." If the process be carried out efficiently the last fraction of percolate will be almost, and in most cases quite, colourless. The efficiency of percolation as a means of exhausting a drug depends upon the fact that the solid material is being continually acted upon by fresh solvent, which displaces the fluid already partially or entirely saturated by contact with the drug. "When liquid ceases to pass, remove the marc from the percolator and submit it to pressure." At the end of the process the marc is left saturated by almost pure menstruum, the soluble constituents having been removed by the fluid which has previously percolated through it. When, therefore, the marc is pressed to recover the imbibed menstruum, the portion of fluid, which is still unavoidably left in, represents, not an appreciable fractional part of the soluble constituents as in the maceration process, but in most cases a negligible proportion, owing to the fact that these constituents have been dissolved by the percolate which has been displaced by the later portions of menstruum poured on. "Filter the expressed liquid, if necessary, either at once or after standing for twenty-four hours." The expressed liquid is nearly always turbid, because the strong pressure expels some of the cell contents which are not soluble, but only mechanically suspended in the liquid, and filtration is, in some cases, facilitated by allowing the liquid to stand and deposit these suspended matters. "Mix the filtrate with the percolate, and then add a sufficient quantity of menstruum to produce the prescribed volume of tincture." It should be observed that the volume of the finished tincture prepared by percolation is adjusted by the addition of menstruum because the process is expected to remove the whole of the soluble constituents, as stated above. Since the loss of alcohol by evaporation during manipulation will be variable and the details of the processes are left to the judgment of the operator, uniformity is secured by bringing the fluid to a definite prescribed volume by dilution when those processes are completed. Compare the remarks made on this point in connection with the process of maceration. Percolation, when properly and carefully conducted, exhausts a drug more completely and by means of a smaller quantity of a menstruum than is possible by maceration alone. But notwithstanding those advantages, the process of simple maceration is still used for preparing many tinctures. The reasons for that may be broadly classified under three heads:—

(1) In the case of bulky drugs, like hops, the available quantity of menstruum is insufficient for the accomplishment of the process of percolation.

(2) Certain drugs yield a powder which is physically unfit for percolation. Thus calumba and squill powders, when moistened, form tough and slimy masses which, unless the powder is very coarse, almost entirely prevent the passage of fluid through them. Again, many resins and gum resins dissolve partly in alcohol, and yield an insoluble residue of a sticky, tenacious nature, which effectually occludes the percolator tube.

(3) In other cases the increased labour involved by percolation is not justi-

fied by the improved exhaustion effected. Thus, if the solid ingredients of a tincture are of small commercial value and at the same time not potent, as in the case of tincture of gentian, or are used in small proportion, as in making tincture of cantharides or compound tincture of lavender, the proportionate part of extractible materials left in the marc after expression is not considered of sufficient value or importance to compensate for the extra time and trouble required for the percolation process, which naturally increase the cost. The process of percolation now described in the Pharmacopœia is given in greater detail than in the 1885 B.P. In the latter the drug to be percolated was directed to be previously macerated in three-fourths of the alcohol, leaving only one-fourth for the displacement of the previously added alcohol. This was in most cases insufficient for the purpose, so that the marc was not by any means exhausted. In preparing the tinctures of the present Pharmacopœia the description of the general process of percolation must be taken in conjunction with the monographs for the required tinctures, where special directions relating to the degree of division of the drug, the amount of menstruum for the preliminary maceration, etc., are given. The following twenty-nine tinctures are prepared by the official process of percolation :—

TINCTURA ACONITI.	TINCTURA HAMAMELIDIS.
„ ARNICÆ.	„ HYDRASTIS.
„ BUCHU.	„ HYOSCYAMI.
„ CASCARILLÆ.	„ JABORANDI.
„ CHIRATÆ.	„ JALAPÆ.
„ CIMICIFUGÆ.	„ KRAMERIÆ.
„ CINCHONÆ.	„ LOBELIÆ ÆTHEREA.
„ CINNAMOMI.	„ PYRETHRI.
„ COLCHICI SEMINUM.	„ QUILLAIÆ.
„ CONII.	„ RHEI COMPOSITA.
„ CUBEBÆ.	„ SENEGÆ.
„ DIGITALIS.	„ SERPENTARIÆ.
„ ERGOTÆ AMMONIATA.	„ STRAMONII.
„ GELSEMI.	„ STROPHANTHI.
TINCTURA ZINGIBERIS.	

(3) **Tinctures made by a Process of Solution or Dilution.**—These tinctures may be divided into two sub-groups (*a*) and (*b*). The tinctures included in sub-group (*a*) are alcoholic solutions of definite chemical substances or proximate principles, and are not made by the selective solvent action of alcohol upon crude drugs. Any such preparation might also be regarded, therefore, either as a solution (Liquor) or spirit (Spiritus), but for convenience the preparations in question are included among the tinctures. They are :—

TINCTURA CHLOROFORMI ET	TINCTURA IODI.
„ MORPHINÆ COMPOSITA.	„ QUININÆ.
„ FERRI PERCHLORIDI.	„ QUININÆ AMMONIATA.

The tinctures included in sub-group (*b*) are made by diluting previously prepared extracts, etc., of certain drugs with alcohol, or dissolving them



therein. This mode of procedure is adopted, in the cases under consideration, either in order to secure more uniformity in composition than could be obtained by using the crude drug, or to obtain standardised tinctures by the dilution with alcohol of the standardised extract of the same drug. This sub-group includes the following tinctures:—

TINCTURA BELLADONNÆ.	TINCTURA CINCHONÆ COMPOSITA.
„ CAMPHORÆ COMPOSITÆ.	„ NUCIS VOMICÆ.
„ CANNABIS INDICÆ.	„ OPII AMMONIATA.
TINCTURA PODOPHYLLI.	

## B.—RELATIVE PROPORTIONS OF DRUG AND MENSTRUUM EMPLOYED.

In devising formulæ for the tinctures two distinct principles may be followed:—(a) To employ the same relative proportion of drug and menstruum in all cases; from which it would follow that the doses of the resulting tinctures would be inversely proportional to the potency of the various drugs from which they had been derived, and would vary within wide limits. (b) To employ relative proportions of the drug and menstruum inversely proportional to their potency. In this case the tinctures would have a uniform dose, but the relative proportions of the various drugs would vary between wide limits. In the British Pharmacopœia, 1898, principle (b) has been adopted. In order, however, to secure uniformity of dose throughout the whole of the tinctures it is obvious that the tinctures of potent drugs, like belladonna and aconite, would have to be prepared with relatively minute proportions and the tinctures of the less potent drugs, like calumba and gentian, with relatively enormous proportions of the drug. This would involve, in the first case, the use of an unnecessarily large proportion of alcohol and, in the second case, inefficient exhaustion from the employment of insufficient menstruum. The principle has, therefore, been modified to the extent of dividing the tinctures into two classes:—

(1) Tinctures of potent drugs, in which the proportions of contained drug are arranged to yield products whose doses shall be from 5 to 15 minims.

(2) Tinctures of less potent or innocuous drugs, having a dose of 30 to 60 minims, *i.e.*, about four times larger than that of the more potent tinctures.

This modification enables the formulæ to be brought within satisfactory working limits, and avoids the two difficulties mentioned above, which are entailed by a rigid adherence to the principle of uniform dosage. The advantages of this system lie entirely on the side of the prescriber, who has practically only two doses to remember, while, for the pharmacist, it is a matter of indifference which principle is adopted, since he is not expected to make the tinctures from memory, but can always refer to the official formulæ. All that need be committed to memory is the proportion of active constituent in each of the more potent tinctures, since that may serve a useful purpose in relation to excessive doses or cases of poisoning.

### C.—ALCOHOLIC STRENGTH OF MENSTRUUA EMPLOYED IN MAKING TINCTURES.

The alcoholic menstrua in the official formulæ, excluding that for tincture of ferric chloride, contain proportions of real alcohol varying from 45 to 90 per cent. by volume. The selection of a menstruum of suitable strength for any given case is determined, in the first place, by its capability to remove the constituents from the drug under the conditions laid down by the formula. The selection has been determined, in most cases, on the basis of experiments made by producing tinctures of each drug with alcoholic menstrua of various strengths, the quality of the products being estimated by their analysis taken in conjunction with their medicinal activity. In cases where the activity of the product depends upon the proportion of some constituent which can be determined by analysis, such as the strychnine in *nux vomica*, the analytical results alone yield reliable data for the selection of a suitable menstruum; but in other cases where the active principle is not easily determined, or where the activity depends upon several, or upon constituents whose identity is not well established, the choice must be guided by clinical experience or pharmacological experiments. In many cases the relative proportion of total extractive matter removable by the various strengths of alcohol may assist in the selection, but too much importance must not be attached to this point, because the activity of this extractive matter may not be in proportion to its quantity. Some drugs are found to be equally well exhausted by alcohol of various strengths; in such cases motives of economy lead to the selection of the lowest strength of alcohol which has the desired solvent action. Alcohol of less than 45 per cent. is not employed in making tinctures, because alcoholic fluids of lower strength than this approximate closely in solvent action to water alone, and tinctures prepared by means of them would resemble infusions more nearly than tinctures. Alcohol of 45 per cent. strength is more than sufficient to preserve vegetable extractive matter from decomposition, but in some cases—*calumba*, for instance—alcohol of this percentage fails to yield a tincture having the desired physical properties. When drugs contain a large proportion of mucilaginous or other inert constituents which are soluble in the weaker alcoholic menstrua, it is sometimes desirable to employ a menstruum containing more alcohol, in which they are less soluble, so as to exclude them from the tincture. The presence of inert mucilaginous or proteid substances renders it difficult to filter the tincture, and to obtain a bright and clear preparation. Thus, tincture of *calumba* is made with 60 per cent. alcohol, although alcohol of lower strength would probably extract the bitter principle equally well. Five of the official tinctures are made with an ammoniated alcoholic menstruum, viz.,

TINCTURA ERGOTÆ AMMONIATA.

„ GUAIACI AMMONIATA.

TINCTURA OPII AMMONIATA.

„ QUININÆ AMMONIATA.

TINCTURA VALERIANÆ AMMONIATA.

In the case of ergot, the addition of ammonia is made because its solvent action upon the active principles of ergot is considered to yield a better product, but in the remaining four cases the ammonia is used because its medicinal

action is desired in association with that of the drugs in question. For a similar reason, spirit of ether is used in making the ethereal tincture of lobelia. In preparing the standardised tinctures by dilution of liquid extracts or other preparations, the fluid used for dilution should approximate in alcoholic strength to that of the preparation to be diluted, in order to avoid the formation of copious precipitates, which would be caused by any marked alteration in the alcoholic strength of the fluid. No absolute rules can be given governing the selection of the alcoholic menstrua. Speaking generally, drugs whose activity depends upon resinous or oily substances yield their virtues most effectually to stronger alcohol, while drugs containing bitter principles require alcohol of medium strength only. No general rule can be formulated for drugs containing alkaloids, for although the free alkaloids are usually more soluble in strong than weak alcohol, their solubility and extraction from the drugs themselves are largely influenced by the state of combination in which they occur, or by the other substances with which they are associated in the drug-tissues.

#### D.—DOSAGE.

As already mentioned in the section dealing with the proportionate quantities of drugs used in making the official tinctures, these preparations fall, broadly, into two groups, one having an ordinary dose of 5 to 15 minims, and the other 30 to 60 minims. Tincture of iodine, having a dose of 2 to 5 minims, is the only exception, although two other tinctures, those of aconite and cantharides, have a smaller dose when their administration is frequently repeated, and 20 to 30 minims of tincture of opium may be given for a single administration. The group of tinctures, whose official ordinary dose ranges from 30 to 60 minims, contains many comparatively innocuous members, which may be given in doses largely exceeding the official limits without danger to the patient, although the quantities indicated are sufficient for the production of the ordinary medicinal action of the drug. The tinctures of rhubarb and senna are given in doses of 2 to 4 fluid drachms when the purgative effect is desired from a single administration. Those points should be borne in mind when criticising the doses of tinctures in prescriptions. Although a dose exceeding 15 minims in the case of the more potent tinctures usually requires some explanation or justification, the official dose of some of the less potent ones may be passed without requiring comment. No official dose is given for the tinctures of arnica and pyrethrum, because those preparations are used exclusively for external application.

#### **Tinctura Aconiti.** TINCTURE OF ACONITE.

Prepared by percolation. Strength, 1 in 20.

[Dose.—5 to 15 minims; if very frequently repeated, 2 to 5 minims.

#### **Tinctura Aloes.** TINCTURE OF ALOES.

Contains some liquid extract of liquorice, and is made from extract of Barbados aloes, by maceration, the reason for the replacement of the aloes by its extract being that the latter yields a less variable, and therefore a better, preparation. Strength, 1 in 40.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm (repeated);  $1\frac{1}{2}$  to 2 fluid drachms (single).

#### **Tinctura Arnicæ.** TINCTURE OF ARNICA.

Prepared by percolation. Strength, 1 in 20.



**Tinctura Asafetidæ.** TINCTURE OF ASAFETIDA.

Prepared by maceration. Strength, 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Aurantii.** TINCTURE OF ORANGE.

Prepared by maceration from fresh peel. Strength, 1 in 4.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Belladonnæ.** TINCTURE OF BELLADONNA.

One part of the liquid extract of belladonna is diluted to 15 parts, by measure, with 60 per cent. alcohol. The product should therefore yield  $0.75/15 = 0.05$  gramme of alkaloids per 100 C.c., or  $0.75/15 = 0.05$  grain in 110 minims, when examined by the process described under Extractum Belladonnæ Liquidum. The official limit of 0.048 to 0.052 gramme per 100 C.c. allows for slight variations due to experimental error in determining small quantities of alkaloids. [Dose.—5 to 15 minims.]

**Tinctura Benzoini Composita.** COMPOUND TINCTURE OF BENZOIN.

Prepared by maceration and contains benzoin, storax, balsam of tolu, and Socotrine aloes. The formula is a very old one, and this tincture has been long used as an application to cuts and wounds on account of the resinous, protective, and antiseptic film which is left after the evaporation of the alcohol. Strength, 1 in 10. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Buchu.** TINCTURE OF BUCHU.

Prepared by percolation. Strength, 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Calumbæ.** TINCTURE OF CALUMBA.

Prepared by maceration. Strength, 1 in 10. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Camphoræ Composita.** COMPOUND TINCTURE OF CAMPHOR.

Made by diluting the previously standardised tincture of opium with 60 per cent. alcohol in which the benzoic acid, camphor, and oil of anise are dissolved. It should contain 0.046 gramme of anhydrous morphine in 100 C.c., or the equivalent of  $1/30$  grain of morphine hydrochloride (or 0.25 grain of opium) per fluid drachm. Opium containing 10 per cent. of anhydrous morphine will contain  $1/40$  grain of the alkaloid in 0.25 grain, and that proportion is equivalent to  $1/30$  grain of morphine hydrochloride. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Cannabis Indicæ.** TINCTURE OF INDIAN HEMP.

One part, by weight, of the extract of Indian hemp is dissolved in 90 per cent. alcohol to produce 20 fluid parts. [Dose.—5 to 15 minims.]

**Tinctura Cantharidis.** TINCTURE OF CANTHARIDES.

Prepared by maceration. Strength, 1 in 80.

[Dose.—5 to 15 minims; if frequently repeated, 2 to 5 minims.]

**Tinctura Capsici.** TINCTURE OF CAPSICUM.

Prepared by maceration. Strength, 1 in 20. [Dose.—5 to 15 minims.]

**Tinctura Cardamomi Composita.** COMPOUND TINCTURE OF CARDAMOMS.

Prepared by maceration, and contains two other aromatics, caraway fruit and cinnamon bark, as well as cardamoms, with raisins to sweeten it. It contains also cochineal, which imparts to the tincture the red colour. Strength, 1 in 80. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Cascarillæ.** TINCTURE OF CASCARILLA.

Prepared by percolation. Strength, 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Catechu.** TINCTURE OF CATECHU.

Prepared by maceration, and contains some cinnamon bark, this flavouring agent being often associated with preparations of astringent remedies. Strength, 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Chiratæ.** TINCTURE OF CHIRETTA.

Prepared by percolation. Strength, 1 in 10. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Chloroformi et Morphinæ Composita.** COMPOUND TINCTURE OF CHLOROFORM AND MORPHINE.

A solution of chloroform, morphine hydrochloride, tinctures of Indian hemp and capsicum, oil of peppermint and hydrocyanic acid in alcohol and glycerin. Each 10 minims of the preparation should contain  $\frac{3}{4}$  minim of chloroform,  $\frac{1}{2}$  minim of diluted hydrocyanic acid, and  $\frac{1}{11}$  grain of morphine hydrochloride. This tincture resembles, in its chief constituents, the articles sold as "chlorodyne." [Dose.—5 to 15 minims.

**Tinctura Cimicifugæ.** TINCTURE OF CIMICIFUGA.

Also known as Tincture of Actæa Racemosa. Prepared by percolation. Strength, 1 in 10. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Cinchonæ.** TINCTURE OF CINCHONA.

Prepared by percolation, and the finished tincture is adjusted in accordance with the result of an assay process. It should yield between 0.95 and 1.05 gramme of cinchona alkaloids per 100 C.c., when examined, as described under Extractum Cinchonæ Liquidum.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Cinchonæ Composita.** COMPOUND TINCTURE OF CINCHONA.

A tincture of dried bitter orange peel, serpentary rhizome, cochineal, and saffron, is prepared with 70 per cent. alcohol by the maceration process, and this is mixed in equal proportions with the simple tincture of cinchona. The compound tincture will, therefore, be half the strength of the simple tincture, and should contain between 0.45 and 0.55 gramme of cinchona alkaloids per 100 C.c., when examined as described under Extractum Cinchonæ Liquidum.

Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Cinnamomi.** TINCTURE OF CINNAMON.

Prepared by percolation. Strength 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Cocci.** TINCTURE OF COCHINEAL.

Prepared by maceration. Strength, 1 in 10. [Dose.—5 to 15 minims.

**Tinctura Colchici Semen.** TINCTURE OF COLCHICUM SEEDS.

Prepared by percolation. Strength, 1 in 5. [Dose.—5 to 15 minims.

**Tinctura Conii.** TINCTURE OF CONIUM.

Prepared by percolation from conium fruit. Strength, 1 in 5.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Croci.** TINCTURE OF SAFFRON.

Prepared by maceration. Strength, 1 in 20.

[Dose.—5 to 15 minims.

**Tinctura Cubebæ.** TINCTURE OF CUBEBS.

Prepared by percolation. Strength, 1 in 5.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.**Tinctura Digitalis.** TINCTURE OF DIGITALIS.

Prepared by percolation. Strength, 1 in 8.

[Dose.—5 to 15 minims.

**Tinctura Ergotæ Ammoniata.** AMMONIATED TINCTURE OF ERGOT.

Prepared by percolation with a menstruum of alcohol and solution of ammonia. The use of ammonia is considered to give a more active preparation, although the grounds for this belief are not clear. Strength, 1 in 4.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.**Tinctura Ferri Perchloridi.** TINCTURE OF FERRIC CHLORIDE.

This is a dilution of 1 part of strong solution of ferric chloride with 1 of 90 per cent. alcohol and 2 of water, and is therefore identical in strength with the official Liquor Ferri Perchloridi, from which it differs only in containing one-fourth its volume of alcohol. The tincture was formerly prepared by diluting the strong solution of ferric chloride with alcohol only, in the belief that the alcohol preserved the ferric chloride from the decomposition to which its aqueous solution is liable. That, however, has been found to be without foundation, and the tincture, although more costly, offers no advantage over the corresponding "liquor." The tincture now contains much less alcohol than formerly, and is probably only retained in deference to the popular demand for "tincture of iron" or "tincture of steel," the preparation being sold by retail in large quantities.

[Dose.—5 to 15 minims.

**Tinctura Gelsemii.** TINCTURE OF GELSEMIUM.

Prepared by percolation. Strength, 1 in 10.

[Dose.—5 to 15 minims.

**Tinctura Gentianæ Composita.** COMPOUND TINCTURE OF GENTIAN.

Prepared by maceration, and contains bitter orange peel and cardamom seeds as flavouring agents. Strength, 1 in 10.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.**Tinctura Guaiaci Ammoniata.** AMMONIATED TINCTURE OF GUAIACUM.

Prepared by solution of the resin in strong alcohol, and contains strong solution of ammonia and the essential oils of lemon and nutmeg. This mixture, like the mixture employed as the menstruum for ammoniated tincture of valerian, resembles aromatic spirit of ammonia in composition. Aromatic spirit of ammonia was formerly used as the menstruum for both these ammoniated tinctures, but the distillation which is necessary in the case of the aromatic spirit itself confers no advantage when the product is used as a menstruum for a coloured tincture—hence a mixture of similar composition is equally good, and the expense and loss incurred in distilling it is avoided.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.**Tinctura Hamamelidis.** TINCTURE OF HAMAMELIS.Prepared by percolation. Strength, 1 in 10. [Dose.— $\frac{1}{2}$  to 1 fluid drachm



**Tinctura Hydrastis.** TINCTURE OF HYDRASTIS.

Prepared by percolation. Strength, 1 in 10. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Hyoscyami.** TINCTURE OF HYOSCYAMUS.

Prepared by percolation. Strength, 1 in 10. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Iodi.** TINCTURE OF IODINE.

Is a solution of 1 part of iodine and 1 of potassium iodide in 1 part of water, diluted to 40 parts with 90 per cent. alcohol. [*Dose.*—2 to 5 minims.]

**Tinctura Jaborandi.** TINCTURE OF JABORANDI.

Prepared by percolation. Strength, 1 in 5. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Jalapæ.** TINCTURE OF JALAP.

Prepared by percolation, and standardised as described under Jalapæ Resina, so as to contain 1·5 grammes of resin per 100 C.c.

[*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Kino.** TINCTURE OF KINO.

Prepared by maceration, and contains glycerin, which is added in the mistaken belief that it retards the gelatinisation to which this tincture is liable on keeping. The cause of this gelatinisation is the oxidation of the kinotannic acid present by an enzyme, which can only be destroyed by the application of heat.

[*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Krameriz.** TINCTURE OF KRAMERIA OR RHATANY.

Prepared by percolation. Strength, 1 in 5. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Lavandulæ Composita.** COMPOUND TINCTURE OF LAVENDER.

Prepared by maceration from the aromatics, cinnamon bark and nutmeg, and red sanders wood, to which it owes its deep red colour. The lavender is introduced in the form of oil of lavender, some oil of rosemary being also added.

[*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Limonis.** TINCTURE OF LEMON.

Prepared by maceration from fresh peel. Strength, 1 in 4.

[*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Lobeliæ Ætherea.** ETHEREAL TINCTURE OF LOBELIA.

Prepared by percolation with spirit of ether. Strength, 1 in 5.

*Dose.*—5 to 15 minims.

**Tinctura Lupuli.** TINCTURE OF HOPS.

Prepared by maceration. Strength, 1 in 5. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Myrrhæ.** TINCTURE OF MYRRH.

Prepared by maceration. Strength, 1 in 5. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Nucis Vomiz.** TINCTURE OF NUX VOMICA.

One part of the fluid extract of nux vomica is diluted with water and 90 per cent. alcohol to produce 6 parts of tincture. It should contain therefore  $1\cdot5 \div 6 = 0\cdot25$  gramme of strychnine per 100 C.c., the official limits being 0·24 to 0·26 gramme, when the product is examined as described under Extractum Nucis Vomizæ Liquidum.

[*Dose.*—5 to 15 minims.]

**Tinctura Opii.** TINCTURE OF OPIUM.

Also known as Laudanum. Opium, 3 parts, is rubbed to a paste with hot water, 10 fluid parts; the mixture is set aside for six hours and then 90 per cent. alcohol, 10 fluid parts, is incorporated with it. The product is allowed to stand for twenty-four hours, strained, pressed, and the mixed products filtered after standing another twenty-four hours. This method effects the disintegration of the opium and is found to be most effectual in exhausting the drug. Moreover it does not entail the preliminary drying and powdering of the opium. The Pharmacopœia allows any variety of opium to be employed in making this tincture, provided that it contains not less than 7.5 per cent. of morphine, calculated as anhydrous. Opium containing less than this proportion of morphine is of inferior quality and may contain an unduly large proportion of alkaloids other than morphine: in this case its action will not fairly represent that of opium of good quality. The filtered tincture, obtained as described above, is assayed for morphine and afterwards diluted, in accordance with the result of this assay, with a mixture of equal volumes water and 90 per cent. alcohol, so that the finished product shall contain 0.75 gramme of morphine, reckoned as anhydrous, in 100 C.c., or 0.75 w/v per cent. The proportion of morphine present is determined in the same manner as described under Opium, except that the measured quantity of tincture, taken for assay, is subjected to a preliminary evaporation in order to remove most of the alcohol which would interfere with the precipitation of the morphine in the later stages of the process.

[Dose.—5 to 15 minims (repeated); 20 to 30 minims (single).]

**Tinctura Opii Ammoniata.**

Standardised tincture of opium is mixed with 90 per cent. alcohol in which benzoic acid and oil of anise are dissolved, and solution of ammonia added. The finished product contains 3 parts of tincture of opium in 20 parts of the ammoniated tincture, and the product should therefore contain the soluble matter of 0.62 grain of opium per fluid drachm, or nearly 5 grains of opium ( $0.62 \times 8 = 4.96$ ) per fluid ounce.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Podophylli.** TINCTURE OF PODOPHYLLUM.

Podophyllum resin is dissolved in 90 per cent. alcohol to yield a solution in the proportion of 1 part (by weight) in  $27\frac{1}{2}$  parts (nearly) by measure, or 2 grains per fluid drachm.

[Dose.—5 to 15 minims.]

**Tinctura Pruni Virginianæ.** TINCTURE OF WILD CHERRY.

Prepared by maceration, the wild cherry bark being first steeped in water for twenty-four hours, in order that the decomposition of the glucoside, which resembles amygdalin, may be ensured, since alcohol coagulates the ferment, emulsin, upon which this decomposition depends. That would prevent the formation of essential oil and hydrocyanic acid—the chief decomposition products of the glucoside—which the preparation is intended to contain. Strength, 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.]

**Tinctura Pyrethri.** TINCTURE OF PYRETHRUM.

Prepared by percolation. Strength, 1 in 5.

**Tinctura Quassia.** TINCTURE OF QUASSIA.

Prepared by maceration. Strength, 1 in 10. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Quillaia.** TINCTURE OF QUILLAIA.

Prepared by percolation. Strength, 1 in 20. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Quininæ.** TINCTURE OF QUININE.

A solution of quinine hydrochloride, 1 part, in 50 parts by measure of tincture of orange. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Quininæ Ammoniata.** AMMONIATED TINCTURE OF QUININE.

Quinine sulphate, 1 part, is added to a mixture of solution of ammonia, 5 parts, and 60 per cent. alcohol, 45 parts (by measure). The alkaloid is precipitated from the sulphate by the ammonia, but the precipitate redissolves in the alcohol. After standing a day or two a slight deposit of cinchonidine forms. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Rhei Composita.** COMPOUND TINCTURE OF RHUBARB.

Prepared by percolation. It is flavoured with cardamom seeds and coriander fruit, and contains  $\frac{1}{10}$  its volume of glycerin, which is probably added to prevent the formation of a deposit on keeping. Strength, 1 in 10.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm (repeated); 2 to 4 fluid drachms (single).

**Tinctura Scillæ.** TINCTURE OF SQUILL.

Prepared by maceration. Strength, 1 in 5. [Dose.—5 to 15 minims.

**Tinctura Senegæ.** TINCTURE OF SENEGA.

Prepared by percolation. Strength, 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Sennæ Composita.** COMPOUND TINCTURE OF SENNA.

Prepared by maceration and flavoured with raisins, as well as with the aromatics, caraway and coriander fruits. The 45 per cent. alcohol is said to yield a more active tincture than stronger alcohol. Strength, 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm (repeated); 2 to 4 fluid drachms (single).

**Tinctura Serpentariæ.** TINCTURE OF SERPENTARY.

Prepared by percolation. Strength, 1 in 5. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Stramonii.** TINCTURE OF STRAMONIUM.

Prepared by percolation. Strength, 1 in 5. [Dose.—5 to 15 minims.

**Tinctura Strophanthi.** TINCTURE OF STROPHANTHUS.

This contains such a small porportion of the seeds, that exhaustion is effected when half the final volume of fluid has been obtained by percolation. The process may therefore be stopped here and the remainder of the alcohol added directly to the percolate. Directions are not given for pressing the marc, probably because the small amount of fluid imbibed by the powder and recoverable by pressure is not considered worth the trouble. Strength, 1 in 40. [Dose.—5 to 15 minims.



**Tinctura Sumbul.** TINCTURE OF SUMBUL.

Prepared by maceration. Strength, 1 in 10. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Tolutana.** TINCTURE OF BALSAM OF TOLU.

Prepared by dissolving balsam of tolu in 90 per cent. alcohol. Strength, 1 in 10. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Valerianæ Ammoniata.** AMMONIATED TINCTURE OF VALERIAN.

Contains some solution of ammonia with which the drug is macerated in association with the alcohol. It contains also some oil of lemon and of nutmeg, so that the total mixed menstruum resembles closely in composition aromatic spirit of ammonia. The use of ammonia in this tincture is based chiefly upon therapeutic reasons, since it assists the stimulant action of the valerian, and develops the strong characteristic odour of the drug. Strength, 1 in 5. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Zingiberis.** TINCTURE OF GINGER.

Prepared by percolation. Strength, 1 in 10. [*Dose.*— $\frac{1}{2}$  to 1 fluid drachm.

## Tragacantha.

**Tragacanth** is a gummy exudation obtained by incision from *Astragalus gummifer*, Labillardière (N.O. Leguminosæ), and other species of *Astragalus* which are found growing in Southern and Eastern Europe, Asiatic Turkey, and Persia. The gum is produced by the transformation (gummosis) of the cell-walls of the medullary rays and pith, and, as it easily absorbs water, it swells and exerts considerable pressure on the surrounding tissues. If the stem, whilst in this state of tension, is accidentally wounded or incised, the expanded tissues contract and the gum is forcibly pressed out in the form of a ribbon, carrying with it the starch grains present in the cells. Though much tragacanth exudes spontaneously, transverse incisions are also made artificially near the base of the stem, in order to promote the flow of gum. The flow continues for several days, and the exudation dries in thick ribbon-like flakes, which are collected and packed in bags. Syrian or Persian tragacanth, which alone is official, is conveyed from ports in the Persian Gulf to Bombay and thence exported to Europe.

**Characters and Test.**—Tragacanth occurs in thin, white or pale yellowish-white, translucent, horny, ribbon-shaped flakes of varying length and breadth, being frequently 2.5 Cm. long and 12 Mm. wide. They are irregularly oblong or more or less curved, marked on the surface with numerous concentric ridges, break with a short fracture, and are inodorous and nearly tasteless. The gum is only sparingly soluble in water, but swells considerably in that liquid, forming a gelatinous mass which may be tinged violet or blue by solution of iodine, owing to the presence of starch. Ash-yield, about 3 per cent.

**Notes.**—The distinctive characters of Syrian tragacanth are the ribbon-like flakes in which it occurs, its insolubility in water, and the presence of but little starch. Smyrna tragacanth, collected in Asiatic Turkey, occurs in flakes of a less ribbon-like character, is more opaque than Syrian tragacanth, and contains much more starch. Caramania, and other inferior varieties of tragacanth are

usually darker in colour and occur in tear-like masses or irregular vermiform pieces; they are sometimes whitened with lead carbonate, which can readily be removed by shaking the pieces with diluted nitric acid and applying to the liquid the usual tests for lead. The chief constituent of tragacanth is about 60 or 70 per cent. of bassorin (traganthin or adraganthin), which is converted by the action of alkalis into isomeric  $\alpha$ - and  $\beta$ -tragacanthan-xylan-bassoric acids; these acids yield, on hydrolysis with dilute sulphuric acid, tragacanthose and xylan-bassoric acid, and the latter can be further hydrolysed into xylose and bassoric acid. The water-soluble portion of tragacanth consists chiefly of polyarabinan-trigalactan-geddic acids, which yield on hydrolysis arabinose, galactose, and geddic acids. Other constituents of tragacanth are starch, cellulose (fragments of cells), and nitrogenous matter.

## Trochisci.

**Lozenges** are prepared by incorporating medicinal substances with powdered refined sugar and a small proportion of powdered gum acacia. This mixture is then made into a dough or stiff paste by the addition of mucilage of acacia, the mass rolled out to a uniform thickness, and portions cut therefrom by means of stamps or cutters of such a size that the cut-out portions shall contain the required quantity of medicament. The cut-out portions are then distributed on trays or shelves, and dried slowly in an air-oven at a moderate temperature to minimise loss of volatile constituents. Lozenges are chiefly employed for the application of remedial agents to the mouth, throat, and upper part of the air passages, their slow solution in the mouth favouring this object. In other cases they constitute a convenient method of administration, particularly for children, as, *e.g.*, in the lozenges of santonin and reduced iron. In the Pharmacopœia Appendix (p. 441) four general formulæ are given for preparing the official lozenges:—

- (1) Preparation with simple basis, in the manner described above.
- (2) Preparation with rose basis, which contains an addition of rose water.
- (3) Preparation with fruit basis, in which black currant paste is added.
- (4) Preparation with tolu basis, in which a small proportion of tincture of balsam of tolu is added.

There are seventeen official lozenges.

Basis.	Trochiscus.	LOZENGE OF	QUANTITY OF MEDICAMENT IN EACH LOZENGE.
Simple	Catechu	CATECHU	1 grain (0.0648 grm.)
	Ferri Redacti	REDUCED IRON	1 grain (0.0648 grm.)
	Santonini	SANTONIN	1 grain (0.0648 grm.)
Rose	Bismuthi Compositus:	COMPOUND BISMUTH	
	Bismuthi Oxycarb.		2 grains (0.1296 grm.)
	Mag. Carb. Pond.		2 grains (0.1296 grm.)
	Calcii Carb. Precip.		4 grains (0.2592 grm.)
	Potassii Chloratis	POTASSIUM CHLORATE	3 grains (0.1944 grm.)
	Sodii Bicarbonatis	SODIUM BICARBONATE	3 grains (0.1944 grm.)

Basis.	Trochiscus:	LOZENGE OF	QUANTITY OF MEDICAMENT IN EACH LOZENGE.
Fruit	Acidi Benzoici	BENZOIC ACID	$\frac{1}{2}$ grain (0·0324 grm.)
	Acidi Tannici	TANNIC ACID	$\frac{1}{2}$ grain (0·0324 grm.)
	Eucalypti Gummi	EUCALYPTUS GUM	1 grain (0·0648 grm.)
	Guaiaci Resinæ	GUAIACUM RESIN	3 grains (0·1944 grm.)
	Ipecacuanhæ	IPECACUANHA	$\frac{1}{2}$ grain (0·0162 grm.)
	Krameria (ext.)	KRAMERIA, OR RHATANY	1 grain (0·0648 grm.)
	Krameria et Cocainæ :	KRAMERIA AND COCAINE	
	Ext. Krameria Cocainæ Hydrochlor.		1 grain (0·0648 grm.) $\frac{1}{30}$ grain (0·0032 grm.)
Tolu	Acidi Carbolici	PHENOL	1 grain (0·0648 grm.)
	Morphinæ (hydrochlor.)	MORPHINE	$\frac{1}{36}$ grain (0·0018 grm.)
	Morphinæ et Ipecacuanhæ :	MORPHINE AND IPECACUANHA	
	Morphinæ Hydrochlor. Ipecacuanha		$\frac{1}{36}$ grain (0·0018 grm.) $\frac{1}{12}$ grain (0·0054 grm.)
Flavoured with tincture of orange	Sulphuris :	SULPHUR	
	Sulphur. Precip.		5 grains (0·324 grm.)
	Potassii Tart. Acid.		1 grain (0·0648 grm.)

## Unguenta.

**Ointments** are mixtures of various medicaments with a fatty basis, intended for external application. When a local or simple protective action is desired, the ointment is smeared upon the surface, or applied on lint or other fabric. If, however, the medicament is intended to be absorbed and to have a general action upon the patient, its application is attended by friction, which, by forcing the ointment into the skin and increasing the local circulation, facilitates its passage through the epidermis. The official ointments may be broadly divided into three groups according to the nature of the fatty basis:—

### (1) OINTMENTS MADE WITH A PARAFFIN BASIS.

Soft and hard paraffins have the advantage of being very inert substances, not easily reacting chemically with the medicaments incorporated with them. Their slow absorption by the skin also favours their employment in making ointments which are intended to have a local action on the skin area to which they are applied. Soft paraffin is too soft for use alone as an ointment base, except in some special cases, and a mixture of hard and soft paraffins is usually employed in order to obtain an ointment of the desired melting point. A mixture of 3 parts of hard and 7 parts of soft paraffin, described in the Pharmacopœia as Unguentum Paraffini, is employed as the usual basis for these ointments. The proportions of hard and soft paraffin in Unguentum Paraffini may be varied to suit the exigencies of climate and prevailing tem-



perature; when used as the basis for ointments containing white substances the white variety of soft paraffin should be employed, while in coloured ointments the yellow (and cheaper) variety of soft paraffin may be used. In ointments containing fluids like creosote and oil of eucalyptus, a considerably larger proportion of hard paraffin than that indicated above is necessary to give the product the desired consistence. Soft paraffin is employed alone in three ointments: with yellow oxide of mercury, because this ointment is chiefly intended for ophthalmic use; with zinc oleate, since this is a hard substance itself; and in making the diluted nitrate of mercury ointment, which is desired to be soft and easily applied. The following ointments are prepared with a paraffin basis:—

Unguentum	OINTMENT OF	PROPORTION OF ACTIVE INGREDIENT.
Acidi Borici	BORIC ACID	I in 10
Acidi Carbolici	PHENOL	I „ 25
Acidi Salicylici	SALICYLIC ACID	I „ 50
Creosoti	CREOSOTE	I „ 10
Eucalypti (Oleum)	EUCALYPTUS	I „ 10
Glycerini Plumbi Subacetatis	LEAD SUBACETATE	I „ 6
Hydrargyri Ammoniati	AMMONIATED MERCURY	I „ 10
Hydrargyri Nitratis Dilutum	DILUTED MERCURIC NITRATE	I „ 5
Hydrargyri Oxidi Flavii	YELLOW MERCURIC OXIDE	I „ 50
Hydrargyri Oxidi Rubri	RED MERCURIC OXIDE	I „ 10
Iodoformi	IODOFORM	I „ 10
Paraffini	PARAFFIN	—
Plumbi Acetatis	LEAD ACETATE	I in 25
Plumbi Carbonatis	LEAD CARBONATE	I „ 10
Plumbi Iodidi	LEAD IODIDE	I „ 10
Zinci Oleatis	ZINC OLEATE	I „ 2

NOTES.—The ointment of carbolic acid contains some glycerin which is added to dissolve the phenol, that substance being insoluble in the paraffin ointment in the required proportion.

## (2) OINTMENTS MADE WITH A BASIS OF LARD.

Lard being an animal fat, and similar in composition to the fat of the human body, appears to be absorbed more freely by the skin than mineral fats like paraffin. It is used as a vehicle for substances of which the absorption is desired, but suffers from two disadvantages as an ointment base—first, a tendency to become rancid; and, secondly, liability to chemical action between it and the medicament. The rancidity of lard is due to the action of organisms which gain access to it, and set up decomposition, resulting in the formation of free fatty acids. This can be prevented to a large extent by the addition of suitable antiseptics; hence, benzoated lard is employed in most cases in preference to plain lard, the benzoic acid and other aromatic substances

extracted from the benzoin having the desired antiseptic action. The following ointments are prepared with a basis of plain lard :—

Unguentum	OINTMENT OF	PROPORTION OF ACTIVE INGREDIENT.
<b>Aconitinæ</b>	ACONITINE	1 in 50
<b>Atropinæ</b>	ATROPINE	1 in 50
<b>Cocainæ</b>	COCAINE	1 in 25
<b>Iodi</b>	IODINE	1 in 25
<b>Veratrinæ</b>	VERATRINE	1 in 50

**Notes.**—The four alkaloidal ointments are prepared by dissolving the respective alkaloids in oleic acid, the solution of alkaloidal oleate forming a homogeneous mixture with the lard, and ensuring uniform distribution. In the form of fat-soluble oleates the bases are also more readily absorbed than in the form of water-soluble salts. Probably benzoated lard is not used for these ointments, lest the benzoic acid should convert the alkaloids into benzoates insoluble in the lard. In iodine ointment the iodine is triturated with potassium iodide and glycerin before adding the lard. Iodine is a sufficiently good antiseptic to preserve the ointment from rancidity.

The following ointments are prepared with benzoated lard :—

Unguentum	OINTMENT OF	PROPORTION OF ACTIVE INGREDIENT.
<b>Belladonnæ</b>	BELLADONNA	1 (liq. ext.) in $1\frac{1}{4}$ or 0.6 per cent. belladonna alkaloids
<b>Cantharidis</b>	CANTHARIDES	1 in 10
<b>Chrysarobini</b>	CHRYSAROBIN	1 in 25
<b>Gallæ</b>	GALL	1 in 5
<b>Gallæ cum Opio</b>	GALL AND OPIUM	7.5 per cent. opium
<b>Hydrargyri Iodidi Rubri</b>	MERCURIC IODIDE	1 in 25
<b>Hydrargyri Oleatis</b>	MERCURIC OLEATE	1 in 4
<b>Hydrargyri Subchloridi</b>	MERCUROUS CHLORIDE	1 in 10
<b>Potassii Iodidi</b>	POTASSIUM IODIDE	1 in 10
<b>Staphisagriæ</b>	STAVESACRE	1 in $5\frac{3}{4}$ (about)
<b>Sulphuris</b>	SULPHUR	1 in 10
<b>Sulphuris Iodidi</b>	SULPHUR IODIDE	1 in 25
<b>Zinci</b>	ZINC	15 per cent. ZnO.

**Notes.**—Belladonna ointment is made by evaporating the standardised liquid extract, and mixing the residue with the lard. The ointments of

cantharides and stavesacre are made by digesting the bruised drugs with the melted lard: cantharides is only partly exhausted by this method. In the ointment of potassium iodide the salt is dissolved in water (with the addition of a small quantity of potassium carbonate, which is added to prevent the appearance of free iodine from decomposition of the iodide) to secure its uniform distribution in the lard. Sulphur iodide is triturated with glycerin to a smooth paste before adding the lard.

### (3) OINTMENTS MADE WITH A BASIS OF WOOL-FAT.

Wool-fat is rapidly absorbed by the skin, and is therefore admirably adapted for a certain class of ointments. It is also capable of forming a homogeneous mixture with aqueous fluids, and water-soluble salts can be incorporated with it with the greatest facility. It is said not to be liable to rancidity, but is, however, very sticky, and is only used in two of the official ointments in the form of hydrous wool-fat.

Unguentum.	OINTMENT OF	PROPORTION OF ACTIVE INGREDIENT.
<b>Conii</b> <b>Hamamelidis</b>	CONIUM HAMAMELIS	2 (evap. juice) in 1 1 (liq. ext.) in 10

**Notes.**—The conium ointment is made by evaporating conium juice to one-eighth its bulk and adding the wool-fat; it often becomes mouldy.

### (4) OINTMENTS MADE WITH OTHER BASES.

#### **Unguentum Aquæ Rosæ.** ROSE-WATER OINTMENT.

Contains rose water and oil of rose incorporated with a melted mixture of white beeswax, spermaceti, and almond oil. When applied to the skin the evaporation of the water absorbs heat and reduces its temperature.

#### **Unguentum Capsici.** CAPSICUM OINTMENT.

Made by digesting bruised capsicum fruit in a melted mixture of spermaceti and olive oil, and straining out the insoluble residue.

#### **Unguentum Cetacei.** SPERMACETI OINTMENT.

A benzoated mixture of spermaceti, white beeswax, and almond oil.

#### **Unguentum Hydrargyri.** MERCURY OINTMENT.

Consists of mercury finely divided by trituration with lard and a small proportion of suet. Contains 1 of metallic mercury in  $2\frac{1}{16}$ .

#### **Unguentum Hydrargyri Compositum.** COMPOUND MERCURY OINTMENT.

Contains mercury ointment mixed with yellow beeswax, olive oil, and camphor; proportion of metallic mercury 1 in 5 (nearly).



**Unguentum Hydrargyri Nitratis.** MERCURIC NITRATE OINTMENT.

Mercury is dissolved in strong nitric acid without the aid of heat. The solution contains chiefly mercurous nitrate, since it is made in the cold, and is deep green in colour, owing to the presence of nitrous acid formed by reduction of a portion of the nitric acid. This cold liquid is added gradually to a melted mixture of lard and olive oil, previously heated to a little above 140° C. The mixture froths up and the olein of the lard and oil is converted into its isomer eläidin, chiefly by the agency of the nitrous acid. This has a much higher melting point than olein; hence, the cold ointment is much firmer than one yielded by a similar mixture of unaltered lard and oil. Eläidin differs also from its isomer, olein, in not reducing the mercuric nitrate, into which the mercurous nitrate is converted when its cold solution in nitric acid is added to the hot fats. Compare the monographs on "Acidum Oleicum" and "Fixed Oils."

**Unguentum Picis Liquidæ.** TAR OINTMENT.

Consists of tar solidified by the addition of yellow beeswax.

**Unguentum Resinæ.** RESIN OINTMENT.

Composed of resin, yellow beeswax, olive oil, and lard, melted together and strained.

## Uvæ Ursi Folia.

**Bearberry Leaves** are obtained from *Arctostaphylos Uva-ursi*, Sprengel (N.O. Ericaceæ), a shrub which is indigenous to Great Britain and distributed throughout Central and Northern Europe and North America. The plant has branching, decumbent stems and scattered leaves with short petioles. The dried leaves alone are used in medicine; they resemble those of buchu in their action, but are more astringent.

**Characters.**—Bearberry leaves are yellowish-green in colour, but darker on the upper than on the under surface. They are more or less rigid, brittle, of a leathery texture (coriaceous), about 18 Mm. long, and reversed ovate (obovate) or like a spatula (spatulate) in shape, the lamina or blade being rounded at the apex and tapering gradually towards the base to a very short stalk or petiole. The margin is entire and slightly rolled back (revolute). In the case of young leaves the margin is fringed with short hairs (ciliate), but those are not often seen, the dried leaves being usually quite smooth and free from hairs (glabrous). The upper surface has a shining and reticulate appearance, a network of depressed veins and veinlets making the surface appear chequered or wrinkled. The greyish-green under surface is also reticulately marked, though very faintly; the veins are somewhat darker in colour than the rest of the under surface and are often slightly raised. The leaves have no distinctive odour, but they have a very astringent taste, owing to the presence of tannin. Ash-yield, about 3 per cent.

**Notes.**—Buchu leaves, which are about the same size as bearberry leaves, have a rhomboidal outline, toothed margin, recurved apex, and a characteristic odour, due to the oil contained in the oil-glands. Other leaves which somewhat resemble bearberry leaves are those of the box (*Buxus sempervirens*), which have a notch cut out at the apex (emarginate), and those of the cowberry (*Vaccinium Vitis-idaea*), which have brown dots scattered over their under surface. The leaves of the pipsissewa or winter-green (*Chimaphila umbellata*), are larger and longer than bearberry leaves, and have serrate margins. The chief constituent of bearberry leaves is 6 to 7 per cent. of tannin; other constituents are a crystallisable glucoside named arbutin, methyl-arbutin, ericolin (probably a mixture), ursone (a colourless, crystalline substance of resinous character) ellagic and gallic acids, quercetin, and probably myricetin. Arbutin is readily decomposed when administered by the mouth, or upon treatment with emulsin or diluted sulphuric acid. One of the products of its hydrolysis is hydroquinone (arctuvine), to which compound the stimulant and antiseptic properties of the drug are said to be partly due. Methyl-arbutin yields methyl-hydroquinone on hydrolysis, and ericolin yields a peculiar-smelling oil named ericinol. Quercetin is a yellow crystalline body, which is also formed when quercitrin is hydrolysed by boiling with dilute mineral acids. Myricetin, another yellow colouring substance, is probably oxyquercetin.

## Valerianæ Rhizoma.

**Valerian Rhizome or Root** is obtained from *Valeriana officinalis*, Linné (N.O. Valerianæ), a plant which is common in England, and widely distributed throughout Europe and Northern Asia. It is cultivated for medicinal purposes in England, Holland, and Germany, and supplies of the drug are obtained chiefly from cultivated plants. The roots of the plant, like those of other perennial plants, tend to merge into a stem-like portion, a short conical rootstock or erect rhizome being thus produced in the case of valerian. The development of the rootstock proceeds for several years before a flowering stem is sent up, slender horizontal branches which terminate in buds being given off meanwhile; from those buds proceed aerial shoots or stolons, which bear cataphyllary leaves and produce fresh plants where they take root. For medicinal purposes, the erect rhizome and roots are collected in the autumn and dried; the lateral shoots are cut off for the purpose of propagating the plant, and the rhizomes, especially when of large size, are cut longitudinally into halves or quarters before being dried.

**Characters.**—Valerian usually consists of the entire or sliced erect rhizome, which is dark yellowish-brown externally, not more than 25 Mm. long, or 12 Mm. thick, and gives off numerous slender brittle roots from 7.5 to 10 Cm. long, whilst short, slender, lateral branches (stolons) are also occasionally present. The rootstock, which is sometimes crowned with the remains of flowering stems and leaves, is usually firm, horny, and whitish or yellowish internally, but old specimens may be hollow, with portions of the tissue remaining as transverse septa or partitions. A transverse section is

irregular in outline and exhibits a comparatively narrow bark, separated by a dark line (cambium) from an irregular circle of wood-bundles of varying size. Parcels of the drug may also contain small undeveloped rhizomes about 6 Mm. long, crowned with the remains of leaves and bearing short slender roots; these young rhizomes have been formed where the stolons given off from mature rootstocks have taken root and produced independent plants. The roots of valerian are of similar colour to the erect rhizome, about 1.5 to 2 Mm. thick, longitudinally striated, and usually not shrivelled to any great extent; a transverse section shows a thick bark and small wood. The characteristic, disagreeable odour of the drug becomes stronger during the process of drying, owing to a change which occurs in the composition of the volatile oil contained in the sub-epidermal layer of cells; no special oil-cells or glands can be detected in the drug. The unpleasant, camphoraceous, and slightly bitter taste is also chiefly due to the volatile oil. Ash-yield, about 8 to 9 per cent.

**Notes.**—Serpentary rhizome, which somewhat resembles small specimens of valerian rhizome, is more slender, and has portions of stem arising from the upper surface in close succession; it also has the pith in an eccentric position and possesses a totally different odour and taste. The chief constituent of valerian is about 0.5 to 1 per cent. of a yellowish-green to brownish-yellow volatile oil (specific gravity 0.93 to 0.96), which is lævo-rotatory and has a strongly acid reaction. Other constituents of the drug are a glucoside, tannin, resin, starch, and the alkaloids chatinine and valerine, concerning which but little is known, except that they are said to form crystalline salts. The oil contains the terpenes pinene, camphene, and probably dextro-rotatory limonene (citrene); also borneol and its formic, acetic, butyric, and isovalerianic esters, together with terpineol and other alcohols, and a sesquiterpene. The bornyl isovalerianate gradually decomposes, yielding free isovalerianic (ordinary valerianic) acid, a colourless oily liquid, with a very strong, sour, disagreeable taste, and possessing the characteristic odour of the drug; its salts have a sweetish taste. The gradual formation of the acid accounts for the increasing intensity of the odour of valerian rhizome during the process of drying. The oil usually contains much free valerianic acid, thus formed.

## Veratrina.

**Veratrine** is an alkaloid, or a mixture of alkaloids, obtained from cevadilla or sabadilla, the dried ripe seeds of *Schænocaulon officinale*, A. Gray (N.O. Liliaceæ), a tall herbaceous plant which grows on low mountain slopes in Mexico, Guatemala, and Venezuela. It produces a tall raceme of yellowish flowers, which are succeeded by small three-celled capsular fruits. As ripening proceeds, each capsule splits through the dissepiments or partitions (septicidally) into three mono-carpellary follicles or fruits, each of which contains from one to six seeds. The dried fruits were formerly imported entire, but the seeds are now usually imported without the thin, brown, papery pericarps. the seeds are of a glossy dark brown or nearly black colour, about 6 Mm. long but much narrower, and taper gradually to an acute point at one extremity, though



more obtuse at the opposite extremity, where the hilum and micropyle are situated. A longitudinal depression with acute edges is usually visible on one side, and the seeds are also slightly curved. On examination with a lens, the surface is seen to be finely wrinkled and, in a transverse section near the obtuse end of a seed, a minute embryo can be detected, imbedded in a large, dark, oily endosperm. The seeds are without odour, but they have an unpleasant bitter and acrid taste due to the presence of veratrine, which is also the cause of the violent sneezing produced by the powdered seeds. It is extracted in an impure condition by exhausting the powdered seeds with 90 per cent. alcohol, the resulting tincture containing the veratrine and other alkaloids combined with a vegetable acid or acids, as they exist in the seeds. The tincture is concentrated until a precipitate begins to fall and then poured into water, the resin and oil of the seeds being thus thrown out of solution, together with a portion of the colouring matter. The liquid is next filtered and solution of ammonia added to the filtrate to decompose the alkaloidal salts, after which the precipitated alkaloids are slightly washed with cold water to free them from adhering impurities, very little water being employed, because the alkaloids are partly soluble in that liquid. The moist precipitate is then suspended in distilled water and dissolved by adding hydrochloric acid, the solution of hydrochlorides being subsequently decolorised by means of animal charcoal, and the alkaloids again precipitated by adding solution of ammonia to the filtrate. Finally, the precipitate is collected on a filter and dried, after being freed from the ammonium chloride by washing with cold distilled water. The product, though known as veratrine, is really a mixture of alkaloids and probably of their derivatives.

**Characters and Tests.**—Veratrine, *i.e.*, the commercial article known by that name, is a pale grey, inodorous, amorphous powder, which causes intense irritation in the nostrils and produces violent sneezing. It is strongly and persistently bitter and intensely acrid. The powder is insoluble, or practically so, in cold water, but soluble in 1,000 parts of boiling water, in 3 parts of 90 per cent. alcohol or of chloroform, or in 6 parts of ether; it is also readily soluble in diluted acids, leaving slight traces of an insoluble, brown, resinous matter. Commercial veratrine yields a yellow solution when dissolved in strong nitric acid, and it dissolves with production of a persistent blood-red colour when warmed with strong hydrochloric acid, while it turns yellow when treated with fifty or sixty times its weight of strong sulphuric acid, the mixture subsequently acquiring a yellowish-green fluorescence, which becomes more distinct on the addition of more acid and slowly changes to bright red or, if warmed, to violet red. The absence of any mineral impurity is shown by "veratrine," when heated with access of air, first melting to a yellow liquid, and then burning away, without leaving any appreciable residue.

**Notes.**—Commercial veratrine, as already stated, is a mixture of alkaloids, etc., the chief constituents being true veratrine, which is also known as cevadine, and veratridine or amorphous veratrine, the first being present in larger proportion. Cevadilline (sabadilline), sabadine, and sabadinine are names which have been applied to other alkaloids extracted from the drug. Veratrine or cevadine,

$C_{33}H_{49}NO_9$ , to which the sternutatory effects of cevadilla are due, occurs in needle-shaped crystals, which may be decomposed into methyl-crotonic (tiglic or cevadic) acid,  $C_5H_8O_2$ , and an amorphous base named cevine (cevedine), by heating with alcoholic potassium hydroxide. Veratridine,  $C_{37}H_{53}NO_{11}$ , which is also known as amorphous veratrine, may be similarly decomposed by alcoholic sodium or potassium hydroxide into dimethyl-protocatechuic (veratric) acid,  $C_9H_{10}O_4$ , and an amorphous base named verine (veratroïne), which is possibly identical with cevine,  $C_{27}H_{43}NO_8$ . On dissolving commercial "veratrine" in alcohol at  $70^\circ C.$ , adding water till turbidity ensues, then evaporating at  $50^\circ$  to  $60^\circ C.$ , crystalline veratrine separates first, then a resinous mixture of veratrine and veratridine, while the mother-liquor contains veratridine and veratroïne veratrate. Cevadilline or sabadilline,  $C_{34}H_{53}NO_8$ , is an amorphous base, which appears to yield methyl-crotonic acid, and probably cevine, on treatment with alcoholic sodium hydroxide; sabadine,  $C_{24}H_{31}NO_8$ , and sabadinine,  $C_{27}H_{45}NO_8$ , are both crystalline bodies, the former being sternutatory, though in a less degree than veratrine. The name "sabatrine" has been applied to an amorphous mixture of decomposition products. The total alkaloid present in cevadilla seeds amounts to less than 1 per cent. They also contain free cevadic and veratric acid, together with fixed oil and resin.

## Vina.

**Wines.**—Medicinal wines closely resemble tinctures. They are mostly made by macerating the drugs in wine, the vinous menstrua employed in official processes being orange wine and sherry. In former times preparations of this class were extensively used, probably because wine then constituted the most readily available alcoholic fluid. The presence of the alcohol confers stability against decomposition in such products, while for many drugs even a weakly alcoholic menstruum is more suitable than water alone. The flavour and odour of the wine at the same time serves to make such preparations more palatable. Wine, being a very variable product, has been in later times displaced to a large extent as a menstruum by plain alcohol, since this is a product of more uniform composition, and can be produced more cheaply by fermentation from starch and sugar than the alcohol, in the form of wine, from grape juice.

### **Vinum Antimoniale.** ANTIMONIAL WINE.

This is made with sherry and contains 2 grains of tartarated antimony in each fluid ounce. The tartarated antimony is not very quickly soluble in alcoholic fluids: hence the direction to dissolve it in a small proportion of boiling water, in which it is freely soluble, and add the resulting solution to the sherry. This removes the chance of any salt remaining undissolved. [*Dose.*—10 to 20 minims; as an emetic, 2 to 4 fluid drachms.]

### **Vinum Aurantii.** ORANGE WINE.

See separate monograph at page 525.

### **Vinum Colchici.** COLCHICUM WINE.

Made from colchicum corm and sherry by the maceration process as described for the tinctures. Strength, 1 in 5. [*Dose.*—10 to 30 minims.]

**Vinum Ferri.** IRON WINE.

Made by macerating 1 part of fine iron wire in 20 fluid parts of sherry in a closed vessel for thirty days, the iron being almost, but not quite immersed in the wine, the vessel being frequently shaken, and the stopper occasionally removed. This is a weak and variable preparation. The solution of the iron probably depends upon the presence in the wine of various free organic acids or acid salts (*vide* Notes on Vinum Xericum) which attack the iron and form soluble compounds therewith resembling in constitution the official iron scale compounds. The formation of rust, *i.e.*, iron oxide, is promoted by partial immersion of the metal in the wine and occasional admission of air, because iron oxide is more easily attacked by acid liquids than the metal itself. The acidity of genuine sherry is variable, and that of plastered or factitious wines still more so: hence the variation in the iron taken up by different samples. Good average samples of Vinum Ferri appear to contain about 0.2 per cent. of iron. [Dose.—1 to 4 fluid drachms.

**Vinum Ferri Citratis.** WINE OF IRON CITRATE.

A solution of iron and ammonium citrate in orange wine, containing 1 grain in each fluid drachm. This preparation was introduced as an alternative preparation to Vinum Ferri, and has the advantage of containing a more definite proportion of iron. [Dose.—1 to 4 fluid drachms.

**Vinum Ipecacuanhæ.** IPECACUANHA WINE.

Made by adding 1 part of liquid extract of ipecacuanha to 19 parts of sherry. The mixture is set aside for forty-eight hours and then filtered, to remove the deposit which forms. The liquid extract being made with 90 per cent. alcohol, extracts from the root various substances—wax, resin, etc.—which are not soluble in the weakly alcoholic wine, but the most important constituents, the alkaloids, appear to be retained in solution. The wine should contain about 0.1 per cent. w/v of ipecacuanha alkaloids.

[Dose.—10 to 30 minims (expectorant); 4 to 6 fluid drachms (emetic).

**Vinum Quininæ.** QUININE WINE.

Contains quinine hydrochloride dissolved in orange wine, 1 grain in each fluid ounce.

[Dose.— $\frac{1}{2}$  to 1 fluid ounce.

**Vinum Xericum.** SHERRY WINE.

See separate monograph at page 527.

**Vinum Aurantii.**

**Orange Wine** is made by fermenting a saccharine solution to which fresh bitter orange peel has been added. It may be prepared by pouring boiling syrup containing about one-fifth its weight of sugar upon the freshly removed rinds of bitter oranges and allowing the whole to stand for twelve hours; yeast must then be added and fermentation allowed to proceed for three days at 18° to 21° C., after which the wine should be strained into a barrel and the alcohol strength brought up, if necessary, to the required percentage by the addition of rectified



spirit. Wine that is weak in alcohol is sometimes preserved by the addition of salicylic acid or sulphites, but such additions are not permissible in the case of wine intended for medicinal purposes. The wine may be detannated as in the case of sherry.

**Characters and Tests.**—Orange wine is officially described as a vinous liquid, having a golden sherry colour; the taste and aroma of the liquid recall those of bitter orange peel. The wine should contain from 10 to 12 per cent. by volume of ethyl hydroxide and be but slightly acid to litmus paper. During fermentation free acids are formed by the action of organisms accompanying the yeast as well as by the yeast organisms themselves. If the process is conducted unskilfully or bad yeast be employed the proportion of acid so formed may be unduly large. The absence of salicylic acid is shown by distilling a mixture of 50 C.c., each of the wine and distilled water with 5 C.c. of normal sulphuric acid solution, rejecting the first 10 C.c. of the distillate and shaking the rest with ether; after the ethereal liquid has been separated and the ether removed by evaporation, the residue should not yield a violet colouration when mixed with ferric chloride solution. The proportion of salicylic acid necessary for preserving inferior qualities of wine is so small that the ferric chloride reaction is not sufficiently distinct in presence of the colouring matter when the reagent is applied to the wine itself. In order to separate the salicylic acid advantage is taken of the fact that it is volatile in steam. When the wine is distilled, the first portion of distillate is rejected, since this contains the bulk of the alcohol of the wine. The remainder of the distillate containing the greater part of the salicylic acid will still probably be too dilute to give a distinct reaction with ferric chloride. Concentration by evaporation is inadmissible because the salicylic acid will volatilise as well. From its aqueous solution, however, the salicylic acid may be extracted by agitation with ether owing to its much greater solubility in that solvent. After separation, the ethereal layer may be evaporated (since salicylic acid does not volatilise at temperatures below the boiling point of ether and in the absence of aqueous vapour), and the residue tested by ferric chloride. This evaporation is best conducted in a white porcelain dish, so that the colour, if any, which is produced on the addition of the reagent shows up distinctly by contrast with the white porcelain. The reason for rejecting the first portion of the distillate, which will contain most of the alcohol of the wine, is that the separation of salicylic acid by ether from dilute alcohol is much less complete than from water only. Hence this alcoholic fraction is collected separately and the remaining portion of the distillate used for the test. Orange wine should yield not more than the slightest reactions with the tests for sulphites.

**Notes.**—The distinctive characters of orange wine are its odour, taste and alcoholic strength. If too little alcohol be present the wine will not keep without the addition of other preservatives which might react with substances administered with orange wine as a vehicle. Salicylic acid may usually be detected by agitating the wine, diluted with water, with ether without previous distillation and applying the ferric chloride reaction to the ethereal residue. Sometimes, however, the ether extracts other substances from the wine which give colour-

reactions with ferric chloride and so render the test uncertain. Excess of acid, usually citric, may be due to the addition to the saccharine solution from which the wine is prepared of the juice of the oranges from which the peel has been obtained.

## Vinum Xericum.

**Sherry** is a white Spanish wine, prepared in the vicinity of Xeres, whence its Latin and English names. It is an alcoholic liquid, made by fermenting the juice of fresh grapes, the fruit of *Vitis vinifera*, Linné (N.O. Ampelideæ), freed from seeds, stems, and skins. White wines, such as sherry, are prepared from the juice or "must" of either white or black grapes, whereas red wines are derived from the "must" of black grapes, fermented with their skins and seeds. The general process for making wine is to express the juice from the ripe grapes and allow the "must," as the liquid is called, to ferment at about 15°·5 C. in vats, fermentation being due to the presence of enzymes secreted by yeast cells. The temperature of the "must" gradually rises, a large quantity of carbon dioxide is evolved, causing a frothy mass (the "head") to form on the surface of the liquid, and the sweet liquid becomes vinous owing to the conversion of the grape sugar into alcohol. The process continues for a prolonged period, and the frothy matter is ultimately precipitated along with colouring matter and tartar, forming a deposit which constitutes the wine-lees. Wines are sweet or dry, according as they contain more or less sugar, a dry wine being without marked sweetness or acidity. Good sherry possesses a dry aromatic flavour and fragrance, with very little acidity, and should contain sufficient alcohol to preserve it, without the addition of salicylic acid or other preservatives. Grape juice alone appears to yield a fermented fluid containing about 13 per cent. of alcohol, but sherry is "fortified" by the addition of rectified spirit after fermentation. For medicinal purposes it is advisable to remove any tannin present in the wine, particularly if it is to be used as a vehicle or menstruum for alkaloid-containing drugs. This may usually be accomplished by macerating 0·15 of gelatin, in No. 100 powder, with 100 of sherry for twenty-four hours, at a temperature not exceeding 15·5° C. (to avoid dissolving the gelatin), and then decanting.

**Characters and Tests.**—Sherry should be of a pale yellowish-brown colour, and contain not less than 16 per cent. by volume of ethyl-hydroxide. The absence of salicylic acid is indicated by the application of the ferric chloride test, as described under *Vinum Aurantii*.

**Notes.**—The distinctive characters of good sherry are its colour, flavour, and alcoholic strength. It consists mainly of ethyl alcohol and water, together with other alcohols, essential oil, various esters, grape sugar, tartaric and malic acids, salts, colouring matter, tannin, etc. The peculiar vinous odour of most wines is due to œnanthylic ethyl ester; the bouquet—flavour and aroma—in different kinds varies, being due to various essential oils and esters. Wine which has been "plastered" by the addition of gypsum or plaster of Paris to the "must" is relatively rich in potassium salts and sulphuric acid. The gypsum decomposes the potassium tartrate or acid tartrate naturally present, potassium sulphate remaining in solution, and the tartaric acid uniting with the lime to

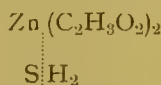
form an insoluble calcium tartrate. The potassium phosphate also naturally present is decomposed to form potassium sulphate and insoluble calcium phosphate; some free sulphuric acid also appears to be formed in plastered wine. The "plastering" of wine is said to be done with the object of improving the colour and assisting the clarification of the liquid, the precipitate formed on adding the calcium sulphate carrying down the suspended matters. The deposits formed by wine on keeping may consist (1) of crystals of potassium bitartrate or neutral calcium tartrate, or both; (2) of colouring matters rendered insoluble by oxidation; (3) of cryptogamic vegetations which cause the liquid to become turbid when shaken, and are liable to give rise to the "maladies" of wines.

## Zinci Acetas.

**Zinc Acetate**,  $\text{Zn}(\text{C}_2\text{H}_3\text{O}_2)_2, 3\text{H}_2\text{O}$ , is prepared by neutralising acetic acid with zinc oxide or carbonate, and crystallising the resulting solution.

**Characters and Tests.**—Thin translucent and colourless plates, having a pearly lustre and sharp, unpleasant taste. Soluble in 2.5 parts of water. It affords the reactions characteristic of zinc and of acetates, and should be free from lead, copper, cadmium, arsenium, iron, aluminium, calcium, magnesium, sodium, potassium, ammonium, chlorides or sulphates.

**Notes.**—The behaviour of solutions of this salt when treated with sulphuretted hydrogen should be carefully noted, as it sometimes leads the student astray in qualitative analysis. When the gas is passed through an aqueous solution of zinc acetate, a white precipitate of zinc sulphide is obtained, because the zinc sulphide is insoluble in acetic acid, although readily soluble in, and hence not precipitated in the presence of, dilute mineral acids. By the action of sulphuretted acid on a neutral metallic salt free acid is always formed in proportion to the sulphide precipitated. Owing to the insolubility of zinc sulphide in acetic acid the formation of the precipitate is possible in the case of zinc acetate—



With the other common salts of zinc, the formation of zinc sulphide under these conditions does not occur, owing to its solubility in the acid which would be set free as a consequence of the reaction. Thus with the sulphate and chloride—



In the ordinary course of analysis, hydrochloric acid is always added before sulphuretted hydrogen is passed through the solution. Zinc acetate has a slight acetous odour. This salt, like lead acetate, loses acetic acid, and becomes converted into a basic acetate. Old samples of the salt may not, therefore, give a clear solution in water without the addition of a little acetic acid to compensate for that lost.

[Dose.—1 to 2 grains.]



## Zinci Carbonas.

**Zinc Carbonate** is prepared by adding a solution of zinc sulphate to a hot solution of sodium carbonate and boiling the mixture, the precipitate being collected, washed, and dried at a gentle heat. Normal zinc carbonate is first formed



but when precipitated as described a part of it reacts with the water producing hydroxide,



while the carbonic acid decomposes with evolution of carbonic anhydride and the precipitate obtained consists of a mixture or weak combination of carbonate and hydroxide in proportions which vary somewhat with the condition under which the operation is conducted (concentration and temperature of reaction-mixture, prolongation of washing, etc.). The official formula,  $\text{ZnCO}_3, [\text{Zn(OH)}_2]_2, \text{H}_2\text{O}$ , may be taken as representing approximately the composition of the hydroxycarbonate as obtained by the method described.

**Characters and Tests.**—A white, tasteless, inodorous powder, insoluble in water, entirely soluble in diluted nitric acid, forming a solution of zinc nitrate. It affords the reactions characteristic of zinc and of carbonates. It should be free from lead, copper, cadmium, arsenium, iron, aluminium, calcium, magnesium, sodium, potassium and ammonium, and contain only traces of chlorides or sulphates.

**Notes.**—The salts of weak bases with weak acid are usually partly hydrolysed when produced from aqueous solution. Native carbonate of zinc, sometimes containing silicate, has been used in medicine under the name of calamine. The calamine found in commerce is often grossly adulterated and frequently appears to be a factitious substance, some samples even containing no zinc compound.

## Zinci Chloridum.

**Zinc Chloride**,  $\text{ZnCl}_2$ , is made by the action of hydrochloric acid on zinc, the resulting solution—purified, if necessary—(*vide* Liquor Zinci Chloridi) being evaporated, and the fused residue of zinc chloride poured into trays or moulds to solidify. The salt is so deliquescent that its aqueous solution will not crystallise under ordinary conditions.

**Characters and Tests.**—Colourless, opaque rods, or tablets, very deliquescent and caustic; almost entirely soluble in water, 90 per cent. alcohol, and ether. It affords the reactions characteristic of zinc and of chlorides. It should be free from lead, copper, cadmium, arsenium, iron, aluminium, calcium, magnesium, sodium, potassium, ammonium, or sulphates.

**Notes.**—Zinc chloride has a great affinity for water, and is often used in chemical operations to withdraw the water formed during reactions; its presence also facilitates many condensation reactions

## Zinci Oxidum.

**Zinc Oxide**,  $\text{ZnO}$ , may be prepared by heating the carbonate to a low red heat, when carbonic anhydride and water (if the hydroxy carbonate be used) are evolved, the residue consisting of zinc oxide; or from metallic zinc by combustion. In the combustion process the zinc is strongly heated in a furnace to vaporise it, and a current of heated air introduced. Direct combination of zinc and oxygen then occurs, and the zinc oxide, very finely divided, is deposited in flues or chambers into which the vapours are conducted.

**Characters and Tests.**—Soft, tasteless, and inodorous powder, which may be white when prepared by combustion, or nearly white when prepared by heating the carbonate. It becomes pale yellow when heated, returning to white as it cools. It affords the reactions of zinc. It should be entirely soluble in 20 per cent. ammonia solution. This test is employed to detect metallic zinc, particles of which may be present through imperfect combustion of the metal in preparing the oxide by this method. The presence of metallic particles is particularly objectionable in zinc oxide which is used, either in the form of dusting powder or ointment, as an application to abraded surfaces. The solubility of zinc hydroxide in excess of ammonia is due to the formation of a soluble double salt. Zinc oxide should be free from lead, copper, cadmium, arsenium, iron, aluminium, calcium, magnesium, sodium, potassium, ammonium, carbonates, chlorides, and sulphates.

**Notes.**—The solubility of zinc oxide and hydroxide in ammonia solution is also utilised in analysis to separate zinc from the other metals of the iron group, the hydroxides of which do not form any soluble double salts with ammonia. The test, as stated in the Pharmacopœia, is somewhat stringent. If an opalescent fluid is obtained, the insoluble matter should be separated and carefully examined for metallic fragments.

*Dose.*—3 to 10 grains.

## Zinci Sulphas.

**Zinc Sulphate**,  $\text{ZnSO}_4, 7\text{H}_2\text{O}$ , is obtained by the action of diluted sulphuric acid on zinc, and crystallisation of the resulting solution.

**Characters and Tests.**—Colourless transparent prismatic crystals with a strong, metallic, styptic taste. Soluble in less than its own weight of water, insoluble in alcohol (like most metallic substances). It affords the reactions characteristic of zinc and of sulphate, should be free from lead, copper, cadmium, arsenium, aluminium, calcium, magnesium, sodium, potassium, ammonium, and acetates, and contain only traces of iron or chlorides.

**Notes.**—Strong sulphuric acid has but little effect on zinc, but the diluted acid is quickly decomposed by that metal, hydrogen being given off and zinc sulphate formed.

[*Dose.*—1 to 3 grains (tonic); 10 to 30 grains (emetic).]

## Zinci Sulphocarbolas.

**Zinc Sulphocarbolate** is the zinc salt of para-phenol-sulphonic acid. The formula given in the Pharmacopœia contains only one molecule of water,

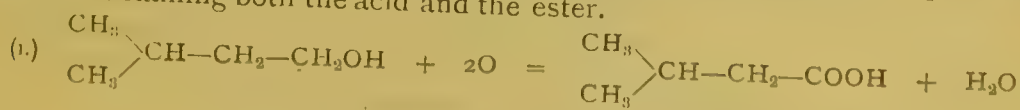
but according to other authorities it contains eight and the formula would be  $\text{Zn}(\text{OH} \cdot \text{C}_6\text{H}_4 \cdot \text{SO}_3)_2, 8\text{H}_2\text{O}$ . It may be obtained by saturating para-phenol-sulphonic acid (the preparation of which will be found described under Sodii Sulphocarbolas) with zinc oxide; or by first preparing the barium salt, which enables one to separate the sulphuric acid accompanying the phenol-sulphonic acid as barium sulphate from the easily soluble and crystallisable barium sulphocarbonate. A solution of the latter salt may then be decomposed by the equivalent quantity of zinc sulphate and the zinc para-phenol sulphonate crystallised from the filtrate.

**Characters and Tests.**—Colourless, transparent, tabular, efflorescent crystals; soluble in 2 parts of water, and in 2.5 parts of 90 per cent. alcohol. The aqueous solution is coloured violet by ferric chloride, and affords a white precipitate of zinc sulphide on the addition of solution of ammonium hydro-sulphide; this test serves to distinguish zinc sulphocarbonate from the corresponding sodium salt. It should be free from lead, copper, cadmium, arsenium, iron, aluminium, calcium, magnesium, sodium, potassium, ammonium, acetates, and chlorides, and contain only traces of sulphate.

**Notes.**—The reaction-mixture containing the para-phenol-sulphonic acid, derived from phenol and sulphuric acid, must also contain excess of the last-mentioned substance. Hence direct neutralisation with zinc oxide will give a solution containing both zinc sulphate and sulpho-carbolate, and since those are both very soluble salts their separation by recrystallisation is somewhat difficult. If the barium salt be first prepared the two acids are easily separated on account of the insolubility of barium sulphate.

## Zinci Valerianas.

**Zinc Valerianate**, or zinc iso-valerianate  $\text{Zn}(\text{C}_5\text{H}_9\text{O}_2)_2$  may be prepared by saturating iso-valerianic acid with zinc oxide and crystallising the resulting solution; or by the interaction of zinc sulphate and sodium iso-valerianate. The iso-valerianic acid is obtained by oxidising the corresponding amyl alcohol. Commercial amylic alcohol or fusel oil is not a pure substance but consists chiefly of iso-amyl alcohol with varying proportions of isomeric and homologous alcohols. The purity of the oxidised product will therefore depend upon the nature of the amylic alcohol employed. If this be shaken with strong brine the lower homologues, ethyl and propyl alcohols, dissolve in the saline solution while the amyl alcohols separate as an oily layer. The oily layer may then be fractionally distilled and the fraction coming over at about  $130^\circ \text{C}$ . will consist chiefly of iso-primary amyl alcohol. When this is treated with chromic acid mixture (potassium bichromate and sulphuric acid) the alcohol is oxidised to the corresponding acid, valerianic acid, and this partly reacts with more amyl alcohol to form the ester, amyl valerianate. By distillation a product is obtained containing both the acid and the ester.





By adding sodium hydroxide to the distillate, the acid is neutralised forming sodium valerianate, and on heating the mixture the ester is saponified with formation of more sodium valerianate and liberation of amyl alcohol.



The alcohol rises to the surface and is separated, whilst the solution of the sodium salt is carefully evaporated to dryness. The direct neutralisation of the acid distillate by zinc oxide is not so satisfactory because the ester is much more rapidly saponified by sodium hydroxide and a larger yield of valerianate obtained. The zinc salt may be obtained by mixing hot solutions (not above 70° C.) of the sodium salt and zinc sulphate, zinc valerianate being precipitated—



or a mixture of the saturated solutions of the two salts may be evaporated cautiously (below 70° C.) to dryness and extracted with alcohol in which sodium sulphate is insoluble.

**Characters and Tests.**—White pearly tabular crystal, with a disagreeable odour and metallic taste, very slightly soluble in water (about 1 in 120) or ether, more soluble in hot water and 90 per cent. alcohol. When heated to redness, after moistening with nitric acid, it should yield not less than 26 nor more than 30 per cent. of ash consisting of zinc oxide. The percentage of ash is a good criterion of quality. For one molecular weight of zinc valerianate  $[\text{Zn}(\text{C}_5\text{H}_9\text{O}_2)_2 = 265.53]$  yields one of zinc oxide  $[\text{ZnO} = 80.79]$ .

$$\therefore 1 \text{ gramme will yield } \frac{80.79}{265.53} \text{ grammes ZnO.} \\ = 0.3043 \text{ or } 30.43 \text{ per cent.}$$

The lower homologues of zinc valerianate such as zinc acetate and butyrate will be found to give a higher percentage of ash, and a similar result would be shown by a sample adulterated with zinc oxide or sulphate. A lower ash would only be shown by the higher homologues of zinc valerianate, or a sample containing an undue proportion of water. The formula for the anhydrous salt is given in the Pharmacopœia, but zinc valerianate crystallises from water with one molecule of water. A salt of this formula,  $\text{Zn}(\text{C}_5\text{H}_9\text{O}_2)_2 \cdot \text{H}_2\text{O}$ , will yield 28.51 per cent. oxide; hence probably the official allowance of 26—30 per cent. of ash. The moistening with nitric acid is done to facilitate the combustion of the last traces of carbon and obviate the risk of reducing the zinc oxide to metallic zinc. Zinc valerianate should be free from lead, copper, cadmium, arsenium, iron, aluminium, calcium, magnesium, sodium, potassium, ammonium, acetates, carbonates, and should contain only traces of chlorides and sulphates. When heated with diluted sulphuric acid it yields a distillate consisting chiefly of the volatile free acids corresponding to the zinc salts present in the sample examined. If this acid distillate be mixed with copper sulphate solution a transparent fluid should at first be obtained, in which little colourless oily drops of anhydrous cupric valerianate appear, passing gradually into a bluish-white crystalline deposit of the hydrated salt. If the sample contain any zinc butyrate (the next lower homologue of valerianate) the butyric acid in the distillate will

give an immediate turbidity of copper butyrate when it is mixed with copper sulphate solution.

**Notes.**—This salt is often subjected to gross sophistication, some samples appearing to be merely zinc oxide or other zinc salt mixed with sufficient impure valerianic acid to communicate the characteristic odour. Although the Pharmacopœia gives the term iso-valerianate as a synonym it can hardly contemplate insisting upon a chemically pure salt of that constitution, as may be inferred from the limit of ash allowed. [Dose.—1 to 3 grains.

## Zingiber.

**Ginger** is the scraped and dried rhizome of *Zingiber officinale*, Roscoe (N.O. Scitamineæ), a native of Asia, which is cultivated in Jamaica and the West Indies, Africa (Sierra Leone), India, Japan, and other tropical countries. It is a reed-like plant with branching rhizomes and is propagated artificially by dividing the rhizomes into “fingers,” each of which contains a bud, and planting the divisions about 30 Cm. apart. Each of the irregularly-branched pieces constitutes a sympodial branching system, consisting of a straight rhizome, from which numerous branches about 2·5 Cm. long are given off in an upward direction. The branches are often slightly compressed laterally when dried and are enlarged near the base; they taper abruptly and each one terminates in the remains of an undeveloped bud or a small depressed scar which indicates the point of attachment of an aerial stem. The branches in turn may give off lateral branchlets which, like the branches themselves, proceed from buds in the axils of cataphyllary leaves. When the growth of the original rhizome or main axis is terminated by the production of an aerial shoot or stem, a bud on its under surface develops, sending down roots and also giving rise to a lateral branch of the rhizome; that branch or “finger,” in turn, produces an aerial stem, and a bud on its under surface then develops in like manner to the first bud, the growth of the rhizome thus proceeding indefinitely. The rhizomes are fit to be collected about twelve months after planting, when the aerial stems have withered. They are then dug up, cleaned, and freed from roots, and are sometimes scalded in boiling water in order to destroy their vitality, before being dried by artificial means. The product constitutes the ordinary ginger of commerce, but in the case of Jamaica ginger, which alone answers the official description, the cork and part of the parenchyma are removed by peeling the washed rhizomes with narrow-bladed knives, after which the rhizomes are again washed and dried in the sun. The product is “scraped” or unbleached Jamaica ginger. Coated or “unscraped” ginger may retain the whole of the cork or have been deprived of it on the flatter sides only. So-called “bleached” ginger has been treated with sulphurous acid or chlorine, or may simply have been dusted over with lime, in order to give it a whitish appearance.

**Characters.**—Ginger is officially described as consisting of flattish, irregularly-branched pieces, varying in length, but commonly from 7·5 to 10 Cm. long, each branch being marked at its summit by a depressed scar. The drug is of a pale buff colour externally, and it breaks readily with a

short, mealy, or sometimes resinous fracture, short scattered fibres—fibro-vascular bundles—usually protruding from the fractured surface. The outer surface of the rhizome is striated and fibrous, the fibres being leaf-traces which pass through the bark to the leaves and are laid bare by the removal of the cork. A transverse section of the drug exhibits a large stele or central column, which is sharply divided from a narrow bark by a fine yellow line; numerous yellow oil-cells are present in both stele and bark. The agreeable, aromatic odour of ginger is due to volatile oil; the hot and pungent taste is mainly due to gingerol. Ash-yield, from 3 to 5 per cent.

**Notes.**—The distinctive characters of Jamaica ginger are the fibrous surface of the pieces, which are known in commerce as “races” or “hands,” the short fracture of the rhizome, the fibres protruding from the fractured surface and the yellow oil-cells. The next best variety is Cochin ginger, which usually occurs in smaller pieces, with shorter branches and a less agreeable aroma; it may be either coated or scraped, the reddish-grey cork on the ventral and dorsal surfaces of the coated rhizomes being coarsely wrinkled both longitudinally and transversely, while the surfaces of the scraped rhizomes are striated and of a rather paler reddish-grey colour. Japanese ginger resembles Cochin, but the pieces are usually smaller and less regular. African ginger occurs in pieces which are about the same size as the Cochin variety, or rather larger, and is more pungent than Jamaica ginger; it is always coated, the ventral and dorsal surfaces bearing patches of earthy-brown wrinkled cork, while the lateral surfaces, from which alone the cork has been removed, are either dingy grey or nearly black. An inferior kind of Jamaica ginger, known as “ratoon” ginger, is obtained by allowing part of the rhizome to remain in the ground when the first crop is collected; it resembles ordinary Jamaica ginger in shape, but is of a dull greyish-brown colour, darker than Cochin ginger, and of inferior aroma and pungency. The chief constituents of ginger are from 1 to 3 per cent. of an aromatic volatile oil, and an intensely pungent, yellowish, oily body named gingerol; it also contains a resin which yields protocatechuic acid, and about 20 per cent. of starch. The viscid, greenish-yellow volatile oil consists principally of a sesquiterpene,  $C_{15}H_{24}$ , together with dextro-camphene and phellandrene, but its composition has not yet been thoroughly investigated. Gingerol is a viscid, inodorous liquid, which is soluble in fats, volatile oils, alcohol, and ether. Gingerine, so-called, is a thick, clear, dark-brown oleo-resinous liquid, which is extracted from ginger by percolation with ether, and contains the whole of the virtues of the drug. Jamaica ginger is said to yield about 5 per cent. of “gingerine,” and East India ginger about 8 per cent. The starch of ginger which has been scalded in boiling water in order to destroy the vitality of the rhizomes is rendered gelatinous by the high temperature, and the drug then appears horny and translucent throughout.



# NOTES ON THE INDIAN AND COLONIAL ADDENDUM (1900) TO THE BRITISH PHARMACOPŒIA 1898.

The Indian and Colonial Addendum (1900) to the British Pharmacopœia, 1898, is a supplement to the latter work, published with the object of better adapting it to Indian and Colonial requirements, as regards important crude drugs and galencial preparations made therefrom. Most of the drugs have been included with the object of serving—in the districts where they are produced—as equivalents of other drugs already official in the Pharmacopœia, the intention being that those drugs and their preparations should be prescribed by the medical practitioner, according to his own judgment of their value. It is not intended, however, that they shall be substituted by the dispenser or pharmacist for the more or less similar articles already included in the Pharmacopœia, except in those cases where authority for such substitution is expressly given in the text. Moreover, the use of each article is only officially sanctioned in those divisions of the Empire which are specially indicated in the Addendum. The following are the divisions of the Empire referred to:—

INDIA.—Ajmer-Merwara, The Andamans, Assam, Bengal, Berar, Bombay, British Baluchistan, Burma, The Central Provinces, Coorg, Madras, The North-west Provinces and Oudh, the Punjab, Sind.

AFRICAN COLONIES.—Basutoland, Bechuanaland Protectorate, Cape of Good Hope or Cape Colony, Gambia, Gold Coast, Lagos, Natal, Northern Nigeria, Southern Nigeria, Orange River Colony, Saint Helena, Sierra Leone, Transvaal.

AUSTRALASIAN COLONIES.—New South Wales, Queensland, South Australia, Tasmania, Victoria, Western Australia; forming the Commonwealth of Australia. British New Guinea, Fiji Islands, New Zealand, Western Pacific.

EASTERN COLONIES.—Ceylon, Hong Kong, Labuan, Mauritius, Seychelles Islands, Straits Settlements.

MEDITERRANEAN COLONIES.—Cyprus, Gibraltar, Malta.

**NORTH AMERICAN COLONIES.**—British Columbia, Manitoba, New Brunswick, North-west Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec; forming the Dominion of Canada. Newfoundland.

**WEST INDIAN COLONIES.**—Bahama Islands, Barbados, Bermuda Islands, British Guiana, British Honduras, Jamaica and Turks and Caicos Islands, Leeward Islands (Antigua, Dominica, Montserrat, Saint Christopher and Nevis, Virgin Islands), Trinidad and Tobago, Windward Islands (Grenada, Saint Lucia, Saint Vincent), the Falkland Islands in the South Atlantic.

The following brief notes must be read in connection with the monographs in the Addendum, which they are intended to amplify and explain:—

## Acaciæ Cortex.

**Acacia Bark** is obtained from *Acacia arabica*, Willdenow (N.O. Leguminosæ), or from *A. decurrens*, Willdenow, being collected from wild or cultivated trees not less than seven years old, then dried, and kept for one year before use. The first-mentioned tree is a native of Arabia and Africa, and is also abundant in India, where the bark is known as “babul” bark; the second is a native of Australia, and is described as the Sydney, or the Victorian and Tasmanian, black wattle, though the tree found in Tasmania is considered by some botanists to be a distinct species, *A. mollissima*, Willdenow. The two barks differ considerably in appearance, but are alike as regards their medicinal properties; they are used in India and the Australasian and Eastern Colonies instead of oak bark, being powerfully astringent. Indian acacia bark is frequently covered with a thick, blackish periderm, while the Australian drug is somewhat twisted and incurved. The bark is richest in tannin when between six and ten years old, and may contain more than 22 per cent. of that substance. It is also stated to contain gallic acid. The gum produced in the stem and branches of acacia trees appears to originate in the cells of the cortex and pericycle, being a product of the transformation (gummosis) of the cell wall, caused by degeneration of the cellulose. It may be found immediately under the bark, where it sometimes collects in cavities, but it usually tends to exude spontaneously, hardening into tears on exposure. The appearance and characters of the gum vary according to the species from which it is obtained, that of *A. arabica* or *A. decurrens* being darker coloured than the official gum acacia, obtained from *A. Senegal* and other species.

## Acalypha.

**Acalypha** is the fresh or dried herb, *Acalypha indica*, Linné (N.O. Euphorbiaceæ), which is indigenous to the hotter parts of India. It possesses expectorant, emetic, and laxative properties, and is used in India and the Eastern Colonies as an equivalent of senega. The leaves of the plant are properly described as ovate, broadly ovate, or rhomboid ovate, without serrations on the lower tapering part. Three principal nerves start from the base of the leaf, the two outer ones branching on the outer side only,

the flower spikes are not as long as the leaves, and it is the female not the male flowers which are enclosed in a funnel-shaped involucre. Other species of *Acalypha* are also used for medicinal purposes in India, *A. paniculata*, Miquel, which possesses similar properties to *A. indica*, having long, petioled, ovate-acuminate, coarsely and equally serrated leaves. The drug contains an alkaloid named acalyphine, together with resin, tannin, and volatile oil.

## Aceta.

**Vinegars.**—Two of the official vinegars (see *ante*, p. 3) have equivalent preparations in the Addendum, Acetum Mylabridis—an equivalent of Acetum Cantharidis—being sanctioned for use in India and the African and Eastern Colonies, while Acetum Urgineæ, an equivalent of Acetum Scillæ, may be used in India and the Eastern Colonies.

### Acetum Mylabridis. VINEGAR OF MYLABRIS.

Process identical with that for Acetum Cantharidis, except that mylabris replaces cantharides.

### Acetum Urgineæ. VINEGAR OF URGINEA.

Process identical with that for Acetum Scillæ, except that urguinea replaces squill. [Dose.—10 to 30 minims.

## Adeps Induratus.

**Indurated Lard** is the purified fat of the hog, *Sus scrofa*, Linné (Order Ungulata), deprived of a portion of its oil by pressure (see *ante*, p. 44). It may be employed in India and the Colonies, when prevailing high temperatures render the official lard too soft for use in ointments or plasters.

## Adhatoda.

**Adhatoda** consists of the fresh or dried leaves of *Adhatoda Vasica*, Nees (N.O. Acanthaceæ), a native of India, which is also known as *Justicia Adhatoda*, Linné. The leaves are opposite and shortly petioled. They possess expectorant and antispasmodic properties, and are official in India and the Eastern Colonies. The fresh leaves are scattered over recently-flooded fields prepared for the rice crop, and are said to destroy aquatic weeds, by causing contraction of their cell-contents and consequent disintegration of their tissues. Adhatoda also acts as a poison upon frogs, leeches, etc., but it appears to have no such effect on the higher animals. The active principle of the drug is a bitter, crystalline alkaloid named vasicine, which is believed to exist in combination with adhatodic acid. Another alkaloid is said to exist in the leaves, together with an odorous volatile principle, one or more organic acids, sugar, mucilage and a large proportion of mineral salts.



## Agropyrum.

**Couch Grass** or **Triticum** is the dried rhizome of *Agropyrum repens*, Beauvois (N.O. Gramineæ), formerly known as *Triticum repens*, Linné, a widely diffused weed which is abundant in fields and waste places in Britain. The plant has a slender creeping rhizome, which may extend for a considerable distance close beneath the surface of the ground, giving off lateral branches occasionally, and marked at intervals of about 2.5 to 5 Cm. by nodes from which leaf buds and slender branching roots are produced. The rhizome is collected in the autumn, freed from rootlets, cut into short pieces, and dried. The drug possesses diuretic and aperient properties, and is official in the Australasian, Eastern, and North American Colonies. The rhizome of *Cynodon dactylon*, Persoon, is somewhat stouter in appearance than couch grass, and contains much starch, as also do other rhizomes which have been confused with couch grass. The latter contains no starch, but about 7 to 8 per cent. of tritacin, a carbohydrate resembling inulin and yielding levulose on hydrolysis; sugar, inosite, mucilage, and acid malates are also constituents of the drug. Lactic acid and mannite may occur in an extract of the rhizome, but are understood to be fermentation products. The rhizome of *Carex arenaria*, Linné, which is much used in Germany for similar purposes to that of couch grass, is stated to contain asparagin, or a substance of similar composition, to which the name "cynodin" has been applied.

## Alstonia.

**Alstonia** consists of the dried bark of *Alstonia scholaris*, R. Brown (N.O. Apocynaceæ), or *A. constricta*, F. von Mueller. The first-named plant is a native of India and the Philippine Islands, where it is known as "dita" bark; the second is an Australian plant, found in New South Wales and Queensland, and known as "Australian Fever Bark." The two barks described under the name of alstonia are very different in many respects, but both possess astringent, tonic, alterative, anthelmintic, and antiperiodic properties. The bark of *A. scholaris* and preparations made therefrom are sanctioned for use in India and the Eastern Colonies, while the use of the bark of *A. constricta* and its preparations is limited to the Australasian Colonies. The bark of *A. scholaris* yields about 2 per cent. of a bitter substance called ditaine, which has been largely used instead of quinine. It contains three alkaloids—ditamine, echitamine, and echitenine. The bark contains about 0.04 per cent. of ditamine, which can be obtained in the form of a bitter crystalline powder. Echitamine is also crystalline, but echitenine is amorphous. Other constituents of the bark are three crystalline bodies, named echicerin, echitin, and echitein, and two amorphous substances—echicaoutchin and echiretin. Those substances are closely allied, and appear to be constituents of the milky juice contained in the laticiferous vessel of the liber. All parts of the plant contain the milky juice (latex), which forms a brownish mass on drying. The bark of *A. constricta* contains the alkaloids alstonine (chlorogenine), alstonicine, porphyrine, and alstonidine, which show a decided blue fluorescence in acid solutions, as also do their salts.

## Andrographis.

**Andrographis** is the dried plant, *Andrographis paniculata*, Nees (N.O. Acanthaceæ), a native of India, where the plant is freely cultivated. The common name of the plant—"kiryat" or "creyat"—is loosely applied to many bitter drugs. The fruit of andrographis is a two-celled capsule, with six to twelve hard, rugose-pitted, and glabrous seeds in each cell. The drug possesses bitter tonic and stomachic properties, and is used in India and the Eastern Colonies as an equivalent of chiretta. A preparation of andrographis has been offered under the name of "Halviva" as a substitute for quinine, and the plant itself has been confounded with chiretta. A kindred species, *A. echinoides*, Nees, which possesses similar properties, is known as "peetumba." Andrographis contains an indifferent bitter principle.

## Aquæ.

**Waters.**—The following official waters, which are usually prepared by distillation (see *ante*, page 74), may be made by an alternative process when required for use in India and other tropical countries:—

AQUA ANETHI.

,, ANISI.

,, CARUI.

,, CINNAMOMI.

AQUA FÆNICULI.

,, MENTHÆ PIPERITÆ.

,, MENTHÆ VIRIDIS.

,, PIMENTÆ.

In each case, the corresponding oil is triturated with twice its weight of calcium phosphate and five hundred times its volume of distilled water, the mixture being subsequently filtered.

## Aristolochia.

**Aristolochia** is the dried stem or root of *Aristolochia indica*, Linné (N.O. Aristolochiaceæ), a native of India. The drug possesses stimulant, tonic, and emmenagogue properties, and is used as an equivalent of serpentary rhizome, in India and the Eastern Colonies. The chief constituent of aristolochia is the volatile oil, to which its peculiar odour and taste are due. Like the oil obtained from serpentary rhizome, it probably contains borneol and pinene. Other constituents of the drug are the alkaloid aristolochine, aristin, aristic acid, resin, tannin and starch.

## Arnica Flores.

**Arnica Flowers** are the dried flower-heads of *Arnica montana*, Linné (N.O. Compositæ), a small plant indigenous to the mountainous districts of central Europe and Siberia. The creeping perennial rhizome and brittle wiry roots of the plant are official in the Pharmacopœia (see *ante*, page 81), but the flowers are used in preference in the North American Colonies. They possess stimulant and irritant properties, and produce a sternutatory effect when powdered. The flower-heads are usually collected entire, but, as the receptacle is especially liable

to be attacked by insects, that portion and the involucre are sometimes removed, the drug then consisting of the ligulate and tubular florets only. The flowers are distinguished from those of *Calendula officinalis*, Linné, and various other composite flowers which have been substituted for or mixed with them, by the narrow, ligulate, three-toothed, seven to nine-veined corollas of the disc florets, the hairy receptacle, the straight spindle-shaped hairy fruit crowned with a whitish bristly pappus, and the hairy, linear-lanceolate involucre bracts. They contain an acrid bitter principle, named arnicin, which is readily dissolved by alcohol, ether, or alkaline solutions, though only slightly soluble in water; other constituents of the drug are a volatile oil, resin, and a phytosterol (arnisterin).

### Aurantii Cortex Indicus.

**Indian Orange Peel** is the fresh or dried outer part of the pericarp of varieties of *Citrus Aurantium* (N.O. Rutaceæ), grown in India and Ceylon, and is sanctioned for use in India and the Eastern Colonies, in making the B.P. preparations for which fresh or dried bitter-orange peel is directed to be used. Indian orange peel is an aromatic bitter, possessing mild tonic properties, and appears to contain the same constituents as bitter-orange peel, its agreeable fragrance being due to the presence of volatile oil and its bitter taste to aurantiamarin, an amorphous bitter principle.

### Azadirachta Indica.

**Indian Azadirach** is the dried bark of the stem of *Melia Azadirachta*, Linné (N.O. Meliaceæ), a native of India, and is also known as "Neem Bark" or "Margosa Bark." It is said to possess cathartic, emetic, and anthelmintic properties, but it is used as an equivalent of quassia, in India and the Eastern Colonies. The chief constituent of Indian azadirach appears to be a bitter, amorphous, indifferent resin, which fuses at 92° C., but it is also stated to contain a crystalline, bitter alkaloid named margosine, together with margosic acid, tannin, and a crystalline body melting at 175° C.

### Belæ Fructus.

**Bael Fruit** is the fresh, half-ripe fruit of *Ægle Marmelos*, Correa (N.O. Rutaceæ, a native of India, where the tree grows both wild and under cultivation. It produces a fruit about the size of a large orange, which has an aromatic flavour and is highly esteemed for its refreshing and astringent properties. The dried fruit was formerly official in the British Pharmacopœia, and the fresh half-ripe fruit from cultivated trees is now used in India and the Eastern Colonies. The distinctive characters of bael fruit are the smooth, hard rind with firmly adherent reddish pulp, the numerous carpels, and the hairy seeds imbedded in mucilage. Mangosteen fruit, from *Garcinia Mangostana*, Linné (N.O. Guttiferæ), has a dark rind to which the pulp is not firmly adherent. The rind of pomegranate fruit, from *Punica Granatum*, Linné (N.O. Lytharieæ),



has a powerfully astringent taste, and exhibits the distinct, shallow, angular depressions left by the seeds. The wood apple, from *Feronia elephantum*, Correa (N.O. Rutaceæ), has a rough exterior and is five-lobed but one-celled. The chief constituent of bael fruit is the exceedingly tenacious pulp, which becomes hard and transparent when dried. When moistened with water, the dried pulp yields a red liquid containing mucilage and pectin, without any appreciable quantity of tannin. The ripe fruits contain tannin, the reaction with ferric chloride being most marked in those portions of the pulp next to the rind. The clear mucilage surrounding the seeds affords no tannin reaction, but is distinctly acid.

## Berberis.

**Berberis** consists of the dried stem of the Nepaul barberry, *Berberis aristata*, De Candolle (N.O. Berberideæ), a native of India and Ceylon. The drug is known as “dārlahad,” under which name are also included the dried stems of *B. lycium*, Royle, and *B. asiatica*, Roxburgh, but only the stem of *B. aristata* is sanctioned for use in India and the Eastern Colonies. It possesses tonic, antiperiodic, and diaphoretic properties. The bitter principle of the drug is berberine, which is present in considerable quantity, together with other alkaloidal matter—probably including oxyacanthine and berbamine, also tannin, resin, gum, and starch.

## Betel.

**Betel** consists of the leaves of *Piper Betle*, Linné (N.O. Piperaceæ), a plant cultivated in the hotter parts of India, Ceylon and the Malay Islands. The leaves possess stimulant, narcotic, and antidyenteric properties, and are sanctioned for use in India and the Eastern Colonies. It is incorrect to describe them as coriaceous and glossy on the upper surface, as they are moderately thin and dull. The warm, aromatic taste of the leaves is due to the presence of a volatile oil (specific gravity 0.958 to 1.044) which consists chiefly of chavibetol (betel phenol or methoxy-chavicol), an isomer of eugenol. It also contains the sesquiterpene cadinene, and may contain chavicol, several terpenes, and other constituents, the composition of the oil varying according as it is obtained from leaves grown in Siam, Java, or elsewhere.

## Buteæ Gummi.

**Butea Gum** or **Bengal Kino** is the inspissated juice obtained from incisions in the stem of *Butea frondosa*, Roxburgh (N.O. Leguminosæ), the “dhak-tree” of Hindostan. The juice may flow from natural fissures in the stem, but is usually obtained from incisions made artificially. It hardens quickly in the form of small, elongated tears, but—owing to its brittle nature—it usually occurs in commerce in small fragments of irregular shape. It is ruby-coloured and almost entirely soluble in water when fresh, but darkens in colour on keeping

and becomes more or less insoluble, the fragments then swelling up in water, like bassorin. The gum possesses astringent properties, and is sanctioned for use in India and the Eastern Colonies as a substitute for East Indian, Malabar, or Madras kino, in making official preparations for which kino is directed to be used. According to the official description it should be only partially soluble in water, but yield about 40 per cent. to 90 per cent. alcohol, the solution being almost colourless. Portions of light-grey corky bark are frequently found adhering to fragments of butea gum, and must be removed before use, together with particles of wood, sand, etc., which are usually present. The drug may contain from 15 to 25 per cent. of such impurities. The chief constituent of the so-called gum is tannin, the proportion of that substance varying from about 15 to 62 per cent., and that of other soluble matters from about 3.5 to 11 per cent., while from 10 to 46 per cent. may consist of insoluble matter. The soluble tannin readily becomes converted into matter which is insoluble in alcohol (see Kino, page 254), and old samples of the drug are therefore unsuitable for preparing tinctures. The insoluble matter into which the soluble tannin is gradually converted dissolves in warm sodium hydroxide solution, with the formation of traces of pyrocatechin, and that fact is believed to indicate the existence in the drug of a catechol-tannic acid altered by oxidation, as no such substance can be detected in a fresh sample of butea gum.

### Buteæ Semina.

**Butea Seeds** are obtained from *Butea frondosa*, Roxburgh (N.O. Leguminosæ), a native of India, where it is known as the "dhak-tree." The seeds possess vermifuge properties, and are used in India and the Eastern Colonies as an equivalent of santonin. Their chief constituent is about 18 per cent. of fat; they also contain about 19 per cent. of albuminoid substances, and 6 per cent. of glucose, together with organic acids, phlobaphene, mucilage, etc. No trace of alkaloidal or glucosidal matter has been found in the seeds. They yield about 5 per cent. of ash on incineration.

### Calotropis.

**Calotropis**, also known as "Mudar" or "Madar," is the dried root-bark of *Calotropis procera*, R. Brown (N.O. Asclepiadæ), or of *C. gigantea*, R. Brown, freed from the outer corky layer. Both trees are natives of India and other Eastern countries, and contain a milky juice which is regarded as a drastic purgative and caustic. The root-barks of the two trees are similar in size and appearance. They possess bitter tonic, and emetic properties, and are official in India and the Eastern Colonies. The drug contains a yellow bitter resin, a black acid resin, a colourless crystalline body (madaralban), an amber-coloured viscid substance (madarfluavil), starch, and caoutchouc. Madaralban and madarfluavil are analogous to alban and fluavil, two resinous constituents of guttapercha. [Dose.—3 to 10 grains (tonic); 30 to 60 grains (emetic).

## Cambogia Indica.

**Indian Gamboge** is the gum-resin obtained from *Garcinia Morella*, Desrousseaux (N.O. Guttiferæ), a native of India, and possesses hydragogue cathartic properties similar to those of Siam gamboge, for which it is used as an equivalent in India and the Eastern Colonies. The finest Indian gamboge has the colour and consistence of Siam gamboge, but it is apt to contain many foreign substances, and, as usually collected, is too impure for commercial purposes. Its chemical composition is essentially the same as that of Siam gamboge, one sample examined having been shown to contain 80·4 per cent. of resin (cambogic acid), and 13·0 per cent. of gum. [Dose.— $\frac{1}{2}$  to 2 grains.

## Catechu Nigrum.

**Black Catechu**, also known as “cutch,” is an extract prepared from the heartwood of *Acacia Catechu*, Willdenow (N.O. Leguminosæ), a tree which is indigenous to India and Burmah. After the tree is felled, the bark and whitish sapwood are removed from the trunk, and the brown or dark-red heartwood is cut into chips and boiled with water until all soluble matter is dissolved. The resulting decoction is strained and evaporated with constant stirring until it attains a thick syrupy consistence, after which the residue is allowed to cool somewhat, spread upon leaves arranged with wooden moulds, and left to harden. The resulting solid extract forms large, brick-like masses, which are broken up and exported in pieces of irregular shape, to which fragments of the leaves may often be found adhering. Catechu of inferior quality is prepared by spreading the syrupy extract upon a mat or cloth, and dividing it by means of a string, while yet soft, into more or less square or oblong pieces. The extract is chiefly used in the dyeing and tanning industries, but, on account of its tonic and astringent properties, is sanctioned for use in India and the Eastern and North American Colonies, in making official preparations for which pale catechu (gambier) is directed to be used. Black catechu yields a dull, reddish-brown powder and, when macerated with cold water, forms a brown magma, in which minute acicular crystals of catechin can be detected on examination under the microscope. It is partially soluble in cold water, almost entirely soluble in boiling water, and yields not less than 80 per cent. to 90 per cent. alcohol. The catechu-tannic acid present causes a dilute aqueous solution to give a dark green colour with aqueous ferric chloride solution (5 per cent.), which changes to purple when the liquid is made alkaline with sodium hydroxide solution. The solution made with boiling water deposits a crystalline sediment of catechin on cooling. The sweetish, astringent taste of the drug is due to the presence of catechin and catechu-tannic acid respectively. As a rule black catechu differs entirely in appearance from gambier or pale catechu (see *ante*, page 121), but as sometimes prepared in India, by allowing the syrupy decoction to crystallise, the product closely resembles gambier; it can, however, always be distinguished from the latter by the absence of the fluorescent substance which is extracted from an alkaline solution of gambier by shaking with petroleum spirit. Otherwise, the composi-



tion of the two drugs is very similar, the chief constituent of black catechu being 25 to 35 per cent. of catechu-tannic acid, while acacatechin (10 to 12 per cent.), quercetin, and catechu-red are also present, together with gum, colouring matter, etc. Catechu-tannic acid is an astringent, brown substance, distinguished from gallotannic acid by forming a greenish-black precipitate with ferric salts, and by not yielding gallic acid on exposure to the air. It is converted into insoluble catechu-red on hydrolysis. Acacatechin forms white needle-shaped crystals, which have a sweetish taste, and on dry distillation yield pyrocatechin (catechol), phenol, and acetic acid; fused with potash it yields phloroglucin and protocatechuic acid. Quercetin is a yellowish-white substance, which occurs in several drugs, and can be formed by hydrolysis from quercitrin, the colouring principle of black oak bark (*Quercus tinctoria*). [Dose.—5 to 15 grains.]

## Cissampelos.

**Cissampelos** is the dried root of *Cissampelos Pareira*, Linné (N.O. Menispermaceæ), a native of tropical and sub-tropical India. The root possesses tonic and diuretic properties. It was formerly official in the British Pharmacopœia as the source of pareira root, and is now used in India and the Eastern Colonies as an equivalent of that drug. Though the diameter of the root is usually about 12 Mm., as described in the Addendum, it is frequently much smaller. The root is distinguished by its dark brown bark, single ring of radial woody wedges, and narrow medullary rays. The extremely bitter taste of the drug is due to the alkaloid beberine (cissampeline, pelosine, or bebeerine), which also occurs in true pareira root (see *ante*, page 342).

## Coscinium.

**Coscinium** is the dried stem of *Coscinium fenestratum*, Colebrooke (N.O. Menispermaceæ), a native of India and Ceylon. It possesses tonic and stomachic properties, and is known as "calumba wood" or "false calumba," having sometimes been used as an adulterant of calumba root. It is now official in India and the Eastern Colonies, where it is used as an equivalent of true calumba. The bitter taste of coscinium is due to the yellow crystalline alkaloid berberine, which is also present in calumba root. The drug is distinguished from calumba (see *ante*, page 106) by its dark yellow colour, hard and woody character, flat surface, and freedom from starch.

## Cucurbitæ Semina Præparata.

**Melon Pumpkin Seeds** are the prepared fresh ripe seeds of cultivated plants of *Cucurbita maxima*, Duchesne (N.O. Cucurbitaceæ), also known as *C. Pepo*, Linné, a native of the Levant. The seeds possess anthelmintic properties, and are recognised for use in the Mediterranean Colonies. They must not be more than one month old, as they are less active if older. They should also have been freshly deprived of their yellowish, membranous envelope or testa, and

of the inner, thin, brownish rind or tegmen. The seeds contain 30 per cent. or more of a reddish fixed oil, together with proteids, sugar, starch, and an acrid resin to which their anthelmintic properties appear to be due.

[Dose.—3 to 4 ounces, bruised to a creamy consistence with water or milk.

## Daturæ Folia.

**Datura Leaves** are the dried leaves of *Datura fastuosa*, Linné, var. *alba*, Nees (N.O. Solanaceæ), or of *Datura Metel*, Linné. Both plants are natives of India, and the drug possesses anodyne and antispasmodic properties. The leaves are used in India, and in the Eastern and West Indian Colonies, as an equivalent of belladonna and stramonium leaves. The chief constituent of the leaves is the alkaloid hyoscyne, with which are associated traces of hyoscyamine and atropine.

## Daturæ Semina.

**Datura Seeds** are obtained from *Datura fastuosa*, Linné, var. *alba*, Nees (N.O. Solanaceæ), a native of India, where the drug is employed as an equivalent of stramonium seeds. It possesses diuretic and narcotic properties. Like the leaves of the same plant, the seeds contain hyoscyne and traces of hyoscyamine and atropine, but oil and resin have also been extracted from the seeds.

## Decocta.

**Decoctions.**—There are seven decoctions official in the Indian and Colonial Addendum, all of them being sanctioned for use in India and the Eastern Colonies, while decoction of acacia bark is also official in the Australasian Colonies, decoction of couch grass in the North American Colonies, and decoction of cotton root bark in the North American and West Indian Colonies.

### Decoctum Acaciæ Corticis. DECOCTION OF ACACIA BARK.

Acacia bark, bruised, 1.25; distilled water, 24. Boil for ten minutes, strain and, if necessary, add water to make 20.

[Dose.— $\frac{1}{2}$  to 2 fluid ounces.

### Decoctum Agropyri. DECOCTION OF COUCH GRASS OR TRITICUM.

Couch grass, cut small, 1; distilled water, 24. Boil for ten minutes, strain, and, if necessary, add water to make 20.

[Dose.— $\frac{1}{2}$  to 2 fluid ounces.

### Decoctum Cissampeli. DECOCTION OF CISSAMPELOS.

Cissampelos, thinly sliced, 2.5; distilled water, 24. Boil for fifteen minutes, strain, and, if necessary, add water to make 20.

[Dose.— $\frac{1}{2}$  to 2 fluid ounces.

### Decoctum Gossypii Radicis Corticis. DECOCTION OF COTTON ROOT BARK.

Cotton root bark, bruised, 4; distilled water, 40. Boil until reduced to 20, strain, and if necessary, add water to make 20.

[Dose.— $\frac{1}{2}$  to 2 fluid ounces.

**Decoctum Hygrophilæ.** DECOCTION OF HYGROPHILA.

Hygrophila, cut small, 2; distilled water, 60. Boil until reduced to 20, strain, and, if necessary, add water to make 20.

[Dose.— $\frac{1}{2}$  to 2 fluid ounces.

**Decoctum Ispaghulæ.** DECOCTION OF ISPAGHULA.

Ispaghula, bruised, 0.274; distilled water, 24. Boil for ten minutes, strain, and, if necessary, add water to make 20.

[Dose.— $\frac{1}{2}$  to 2 fluid ounces.

**Decoctum Sappan.** DECOCTION OF SAPPAN.

Process identical with that for Decoctum Hæmatoxyli, except that sappan replaces logwood.

[Dose.— $\frac{1}{2}$  to 2 fluid ounces.

## Embelia.

**Embelia** is the dried fruit of *Embelia Ribes*, Burmann (N.O. Myrsinaceæ), or of *E. robusta*, Roxburgh, the drug possessing anthelmintic properties. Both plants are natives of India, and the fruits are used there and in the Eastern Colonies as an equivalent of kousso or male fern. The slightly astringent and aromatic taste of the berries appears to be due to the presence of tannin and volatile oil, but the active principle seems to be embelic acid; the fruit also contains fixed oil, colouring matters, and a resinoid body.

[Dose.—60 to 240 grains in powder.

## Emplastra.

**Plasters.**—In India and the Colonies, more or less hard soap, indurated lard, resin, or yellow beeswax, may be employed in the preparation of the plasters of the text of the Pharmacopœia or of the Addendum, when prevailing high temperatures otherwise render the basis too soft for convenient use; but the official proportion of the active ingredient must in all cases be maintained. The two plasters included in the Addendum are sanctioned for use in India, and in the African and Eastern Colonies.

**Emplastrum Calefaciens Mylabridis.** WARMING PLASTER OF MYLABRIS.

Process identical with that for Emplastrum Calefaciens, B.P., except that mylabris replaces cantharides.

**Emplastrum Mylabridis.** MYLABRIS PLASTER.

Process identical with that for Emplastrum Cantharides, B.P., except that mylabris replaces cantharides, and prepared suet may be used in India instead of lard.

## Extracta Liquida.

**Liquid Extracts.**—Any official liquid extract containing less than one-fourth of its weight of 90 per cent. alcohol may have the proportion of that spirit increased to an amount not exceeding one-fourth of the total weight in



India and other tropical countries, where otherwise the preparation would be liable to ferment. In the case of nine of the eleven extracts included in the Addendum, the strength of the finished product is so adjusted that each fluid part shall represent one part of the drug, the latter being exhausted and the liquid product evaporated to a definite volume. The exceptions are the liquid extract of cissampelos and the spirituous extract of liquorice.

**Extractum Acalyphæ Liquidum.** LIQUID EXTRACT OF ACALYPHA.

Dried acalypha in No. 40 powder is exhausted by percolation with 90 per cent. alcohol. India and the Eastern Colonies. [*Dose*.—5 to 30 minims.

**Extractum Adhatodæ Liquidum.** LIQUID EXTRACT OF ADHATODA.

Dried adhatoda in No. 40 powder is exhausted by percolation with 60 per cent. alcohol. India and the Eastern Colonies. [*Dose*.—20 to 60 minims.

**Extractum Agropyri Liquidum.** LIQUID EXTRACT OF COUCH GRASS OR TRITICUM.

Couch grass, cut small, is exhausted by digestion with boiling distilled water, and alcohol is added as a preservative. Australasian, Eastern, and North American Colonies. [*Dose*.—1 to 2 fluid drachms.

**Extractum Belæ Liquidum.** LIQUID EXTRACT OF BAEL.

Bruised bael fruit is exhausted by maceration with distilled water, and alcohol added. India and the Eastern Colonies.

[*Dose*.—1 to 2 fluid drachms.

**Extractum Cissampeli Liquidum.** LIQUID EXTRACT OF CISSAMPELOS.

Process identical with that for Extractum Pareiræ Liquidum, cissampelos replacing pareira root. India and the Eastern Colonies.

[*Dose*.— $\frac{1}{2}$  to 2 fluid drachms.

**Extractum Glycyrrhizæ Spirituosum.** SPIRITUOUS EXTRACT OF LIQUORICE.

Extract of liquorice is diluted with distilled water and 90 per cent. alcohol added as a preservative, the finished product containing 50 per cent. of extract of liquorice. India and the Eastern Colonies.

[*Dose*.— $\frac{1}{2}$  to 1 fluid drachm.

**Extractum Gossypii Radicis Corticis Liquidum.** LIQUID EXTRACT OF COTTON ROOT BARK.

Cotton root bark, in No. 30 powder, is exhausted by percolation with a mixture of glycerin and 90 per cent. alcohol. India, and the Eastern, North American, and West Indian Colonies. [*Dose*.— $\frac{1}{2}$  to 1 fluid drachm.

**Extractum Grindeliæ Liquidum.** LIQUID EXTRACT OF GRINDELIA.

Grindelia, in No. 40 powder, is exhausted by maceration and percolation with 90 per cent. alcohol, after which the alcohol is recovered by distillation, and the residue dissolved in distilled water, to which sodium bicarbonate has previously been added, in order to

neutralise the acid resin of the drug. After effervescence ceases, the strength of the preparation is duly adjusted. Australasian and North American Colonies. [Dose.—10 to 20 minims.

**Extractum Kavæ Liquidum.** LIQUID EXTRACT OF KAVA.

Kava rhizome, in No. 20 powder, is macerated and percolated with 90 per cent. alcohol. Australasian Colonies. [Dose.—30 to 60 minims.

**Extractum Picrorhizæ Liquidum.** LIQUID EXTRACT OF PICRORHIZA.

Picrorhiza, in No. 60 powder, is exhausted by percolation with 60 per cent. alcohol. India and the Eastern Colonies. [Dose.—20 to 60 minims.

**Extractum Viburni Prunifolii Liquidum.** LIQUID EXTRACT OF BLACK HAW.

Black haw, in No. 60 powder, is exhausted by percolation with 70 per cent. alcohol. North American Colonies. [Dose.—1 to 2 fluid drachms.

## Gossypii Radicis Cortex.

**Cotton Root Bark** is the dried root-bark of *Gossypium herbaceum*, Linné (N.O. Malvaceæ), a native of Asia, cultivated in most tropical countries. The root-bark possesses emmenagogue properties, and is used in India and in the Eastern, North American, and West Indian Colonies, as an equivalent of ergot. The active principle of the drug is about 8 per cent. of a pale yellow or colourless acid resin, which turns red on keeping and is soluble in alcohol, chloroform, ether, or benzene. Other constituents of the drug are fixed oil, gum, tannin, sugar, and chlorophyll.

## Grindelia.

**Grindelia** consists of the dried leaves and flowering tops of *Grindelia camporum*, Greene, *G. squarrosa*, Dunal, and *G. robusta*, Nuttall (N.O. Compositæ), perennial herbs indigenous to North America, and found in the plains to the south-west of the Rocky Mountains. Part of the drug is said to be derived from *G. cuneifolia*, and *G. cuneifolia*, var. *paludosa*. In each case, the flower-heads secrete a white, sticky resin before they expand, and in May and June, when the leaves and flowering tops are collected and dried, the whole plant is resinous. The drug possesses sedative and antispasmodic properties, and is official in the Australasian and North American Colonies. As found in commerce, the drug consists of the branching, yellow, upper portions of the stem, bearing the capitula and a few leaves, but the dried stems are frequently stripped of their leaves, and broken leaves and detached flower-heads are common in parcels of the drug. The chief constituents of grindelia are amorphous resins, of which as much as 21 per cent. may be present. Other constituents are lævo-glucose, tannin, and a trace of volatile oil.

## Gummi Indicum.

**Indian Gum**, also known as "Ghāti" or "Ghatti" gum, is an exudation from the wood of *Anogeissus latifolia*, Wallich (N.O. Combretaceæ), a native of India and Ceylon. It possesses demulcent properties and is sanctioned for use, in India and the Eastern Colonies, in making B.P. preparations for which gum acacia is directed to be used, one part of it being taken for every two parts ordered of gum acacia, as it possesses about double the viscosity of the latter. Indian gum should be entirely soluble in water, forming a viscid adhesive mucilage, but is insoluble in 90 per cent. alcohol. Its reactions closely resemble those of gum acacia, but it yields only a slight precipitate with lead subacetate, while gum acacia forms an opaque white jelly with that reagent. The ferric chloride and lead acetate tests serve to show the absence of Amrad and other inferior gums, some of which contain tannin and give a bluish-black coloration with ferric chloride, while others are precipitated by lead acetate; the iodine test serves to prove the absence of starch or commercial "dextrin" (see *ante*, page 2). Indian gum forms a colourless or nearly colourless mucilage with water, and is said to be a better emulsifier than any other gum. The constituents of Indian gum are similar to those of gum acacia.

## Hirudo Australis.

**Australian Leeches**, or "five-striped" leeches, *Hirudo quinquestriata*, Schmarda (Order Gnathobdellida), also known as *H. australis*, Bosisto, or *Limnoddella quinquestriata*, R. Blanch, are used in the Australasian Colonies instead of European leeches. They are distinguished from the latter by having five instead of six longitudinal stripes on the dorsal surface, and by the absence of spots on the ventral surface.

## Hygrophila.

**Hygrophila** is the dried herb, including the root, of *Hygrophila spinosa*, T. Anderson (N.O. Acanthaceæ), a native of India, also known as *Asteracantha longifolia*, Nees. The drug possesses demulcent and diuretic properties, and is official in India and the Eastern Colonies. The chief constituent of the drug is mucilage, but it also contains traces of alkaloidal matter, together with phytosterol, fixed oil, etc. The seeds of the plant are glutinous as well as mucilaginous, containing the equivalent of more than 31 per cent. of albuminoids; they also contain traces of an alkaloid and 23 per cent. of a yellow fixed oil.

## Infusa.

**Infusions.**—There are six infusions included in the Addendum, all of them being official in India and the Eastern Colonies, while infusion of alstonia is also official in the Australasian Colonies.

**Infusum Alstoniæ.** INFUSION OF ALSTONIA.

Bruised alstonia, 1 part, is infused for thirty minutes with boiling distilled water, 20 parts. Strain. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.



**Infusum Andrographidis.** INFUSION OF ANDROGRAPHIS.

Process identical with that for Infusum Chiratae, except that andrographis replaces chiretta. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.

**Infusum Azadirachtæ Indicæ.** INFUSION OF INDIAN AZADIRACH.

Process identical with that for Infusum Quassiae, except that Indian azadirach replaces quassia. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.

**Infusum Coccinii.** INFUSION OF COSCINIUM.

Process identical with that for Infusum Calumbæ, but coccinium replaces calumba root, and boiling water is used. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.

**Infusum Tinosporæ.** INFUSION OF TINOSPORA.

Process identical with that for Infusum Calumbæ, but tinospora replaces calumba root, and twice the quantity is used. [Dose.— $\frac{1}{2}$  to 1 fluid ounce.

**Infusum Toddaliæ.** INFUSION OF TODDALIA.

Process identical with that for Infusum Cuspariæ, but toddalia replaces cusparia bark, and twice the quantity is used. [Dose.—1 to 2 fluid ounces.

## Ispaghula.

**Ispaghula** consists of the dried seeds of *Plantago ovata*, Forskohl (N.O. Plantaginaceæ), a native of India and Persia, also known as *P. Ispaghula*, Roxburgh. The seeds possess demulcent properties, and are used in India and the Eastern Colonies as an equivalent of linseed or barley. The testa of the seeds contains mucilage, which can be extracted by soaking the seeds in water, a thick viscid fluid being obtained, as in the case of linseed when similarly treated. The seeds also contain proteids and fixed oil.

[Dose.—50 to 150 grains, in powder.

## Kaladana.

**Kaladana** or **Pharbitis Nil** consists of the dried seeds of *Ipomœa hederacea*, Jacquin (N.O. Convolvulaceæ), a native of India. The seeds are described as having the form of a segment of a sphere, but their shape is more exactly defined as resembling that of a segment of an orange, being triangular, with one side convex. The drug possesses purgative and anthelmintic properties, and is used in India and the Eastern Colonies as an equivalent of jalap, its chief constituent being about 8 per cent. of a resin named pharbitisin; other constituents are fixed oil, mucilage, proteids and tannin.

[Dose.—30 to 50 grains, in powder.

## Kaladanæ Resina.

**Kaladana Resin** or **Pharbitisin** is extracted from the dried seeds of *Ipomœa hederacea*, Jacquin (N.O. Convolvulaceæ), by the same process as is employed for the extraction of jalap resin. It possesses hydragogue cathartic properties, and is used as a substitute for jalap resin in India and the Eastern Colonies. It is soluble in 90 per cent. alcohol, but insoluble in ether, and is apparently identical with jalapin (convolvulin). It melts at 140° C. and yields sebacic acid when heated with nitric acid. [Dose.—2 to 8 grains.

## Kavæ Rhizoma.

**Kava Rhizome** consists of the decorticated, dried, and divided rhizome, without the roots, of *Piper methysticum*, Forster (N.O. Piperaceæ), a native of the Sandwich Islands. The official description applies to the prepared drug as it occurs in commerce; it occurs naturally as a large, somewhat woody and starchy rhizome, with the roots attached. The rhizome is also more or less porous and exhibits rings of woody tissue. The prepared rhizome is official in the Australasian Colonies. The active constituents of the drug are  $\alpha$ -kava and  $\beta$ -kava resins; other constituents are two inactive crystalline bodies—kavahin (methysticin) and yangonin, and about 50 per cent. of starch; an alkaloid named kavaine is also said to be present, but that statement requires confirmation. Kava possesses stimulant, diuretic, diaphoretic, and tonic properties; an alcoholic extract of the drug acts as a local anæsthetic, and an intoxicating drink can be prepared from the fresh root.

## Kino Eucalypti.

**Eucalyptus** or **Botany Bay Kino** is an exudation from the stem of various species of *Eucalyptus* (N.O. Myrtaceæ), which should have the characters and respond to the tests for ordinary kino. It is found as dried masses in the crevices of the trees, but may also be obtained by incision, and usually occurs in dark reddish-brown masses or grains, which appear translucent and garnet-like when sufficiently thin. The drug is very apt to contain much foreign matter, especially fragments of bark removed in scraping the kino from the trees. Its physical characters and behaviour with solvents may also vary considerably, owing to the different sources from which it is obtained. It possesses astringent properties, and is sanctioned for use in the Australasian Colonies, in making the official preparations for which East India, Malabar, or Madras kino is directed to be used. The constituents of eucalyptus kino vary, but it may contain as much as 47 per cent. of kinotannic acid, together with catechin, pyrocatechin, a gelatinisable tannin glucoside, kino-red, and about 15 per cent. of moisture. Eucalyptus kinos are said to contain two varieties of tannin, one of which gelatinises readily and gives a violet colouration with ferric chloride, while the other gives a green colouration. Eucalypti Gummi (see page 165) is a variety of Botany Bay kino. [Dose.—5 to 20 grains, in powder.

## Limonis Cortex Siccatus.

**Dried Lemon Peel** is the dried outer part of the pericarp of the fruit of *Citrus Medica*, Linné, var.  $\beta$ -*Limonum*, Hooker filius (N.O. Rutaceæ), and may be used in India and the Colonies, in making official preparations for which fresh lemon peel is directed, when the fresh peel cannot be obtained. The peel possesses bitter, stomachic, and tonic properties.

## Liquores.

**Solutions.**—Six of the seven Liquors in the Addendum are so-called “concentrated solutions,” and all are official in India and the Eastern Colonies.

Liquor Epispasticus Mylabridis is an equivalent of Liquor Epispasticus, and is sanctioned for use in India and in the African and Eastern Colonies.

**Liquor Andrographidis Concentratus.** CONCENTRATED SOLUTION OF ANDROGRAPHIS.

Process identical with that for Liquor Chiratae Concentratus, except that andrographis replaces chiretta. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Liquor Aristolochiæ Concentratus.** CONCENTRATED SOLUTION OF ARISTOLOCHIA.

Process identical with that for Liquor Serpentariæ Concentratus, except that aristolochia replaces serpentry rhizome.

[Dose.— $\frac{1}{2}$  to 2 fluid drachms.

**Liquor Berberidis Concentratus.** CONCENTRATED SOLUTION OF BERBERIS.

Process identical with that for Liquor Serpentariæ Concentratus, except that berberis replaces serpentry rhizome. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Liquor Coscinii Concentratus.** CONCENTRATED SOLUTION OF COSCINIUM.

Process almost identical with that for Liquor Calumbæ Concentratus, but coscinium replaces calumba root, the quantity of alcohol is increased, and that of water is reduced.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Liquor Epispasticus Mylabridis.** BLISTERING LIQUID OF MYLABRIS.

Process identical with that for Liquor Epispasticus, except that mylabris replaces cantharides.

**Liquor Tinosporæ Concentratus.** CONCENTRATED SOLUTION OF TINOSPORA.

Process identical with that for Liquor Calumbæ Concentratus, except that tinospora replaces calumba root.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Liquor Toddaliæ Concentratus.** CONCENTRATED SOLUTION OF TODDALIA.

Process identical with that for Liquor Cuspariæ Concentratus, except that toddalia replaces cusparia bark.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

## Mucilago Gummi Indici.

Mucilage of Indian Gum may be employed in India and the Eastern Colonies, in making the official preparations for which Mucilago Acaciæ is directed to be used. The process by which it is made is identical with that for Mucilago Acaciæ, except that Indian gum replaces gum acacia and only half the proportion is used.

## Mylabris.

Mylabris is the dried beetle, *Mylabris phalerata*, Pallas (Order Coleoptera), one of the so-called Chinese blistering flies or beetles, found in China, India, etc. It is an irritant poison, possessing diuretic, aphrodisiac, rubefacient, and vesicant properties. The beetles are richer in cantharidin than cantharides and, together with other species containing an equivalent proportion of that



substance, may be used in India and in the African and Eastern Colonies, in making preparations corresponding to the official preparations of cantharides. The beetles have two long black and orange elytra or wing-sheaths, under which are two brown membranous wings. In the case of *M. phalerata*, the beetle usually measures 25 Mm. or more in length and 9 Mm. broad, the elytra being black, with two broad, wavy, transverse, orange-coloured bands, and a large orange-coloured spot at the base of each. When examined under a lens the bands are seen to bear black, bristly hairs. *M. cichorii* is usually smaller than *M. phalerata* and bears brighter-coloured bands covered with a yellow downy pubescence, the hairs on the black portions of the elytra being also black. Other species—*M. bifasciata* and *M. lunata*—are found in South Africa. The different species contain from 1 to 1·2 per cent. of cantharidin, together with fat, a disagreeable odorous principle, and other extractive matter.

## Myrobalanum.

**Myrobalans** are the dried immature fruits of *Terminalia Chebula*, Retzius (N.O. Combretaceæ), a native of India. The statement that the dried fruits are usually distinguished in commerce as Chebulic myrobalans is incorrect; they are commonly known as black myrobalans (*Myrobalani indicæ* or *nigræ*), Chebulic myrobalans consisting of the much larger, matured, brownish fruits. Myrobalans possess purgative properties when ripe, but the immature fruits are chiefly used on account of their astringent properties, being employed in India and the Eastern Colonies as an equivalent of galls. They contain from 20 to 40 per cent. of tannic acid, also gallic acid, fatty acid, resins, glucose, a bitter principle, and colouring matter. [Dose.—30 to 60 grains in powder.

## Oleum Ajowan.

**Ajowan Oil** or **Ptychotis Oil** is obtained by distillation from the fruit of *Carum copticum*, Bentham and Hooker filius (N.O. Umbelliferæ), one of the sources of thymol. The plant is a native of Africa, and is found in Egypt, Persia, and Afghanistan; it is also cultivated in India. The oil possesses aromatic, stomachic, and carminative properties, and is used in India and the Eastern Colonies as an equivalent of the oils of anise, caraway, dill, or peppermint. The comminuted fruit yields from 3 to 4 per cent. of a colourless volatile oil (specific gravity 0·917 to 0·930) on distillation. It resembles thyme in odour and taste, the latter being pungent and aromatic. The optical rotation of the oil is from +1·0° to +1·5° when cooled to 0° C. The oil should yield from 30 to 36 per cent. of crystalline thymol, that being its chief constituent. The thymol may be present to the extent of 45 to 55 per cent., but only part of it crystallises out on cooling, though complete separation can be effected by shaking the oil with sodium hydroxide solution. In addition to thymol, the oil contains "thymene," a mixture of cymene and a terpene boiling at 172° C.

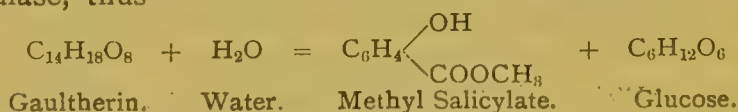
[Dose.— $\frac{1}{2}$  to 3 minims.

## Oleum Arachis.

**Arachis Oil**, also known as earth-nut, ground-nut, or peanut-oil, is obtained by expression, without the aid of heat, from the seeds of *Arachis hypogæa*, Linné (N.O. Leguminosæ), a native of Africa, which is cultivated in India, China, and America. The seeds contain about 45 per cent. of fixed oil (specific gravity 0.916 to 0.918) which is extracted by grinding the seeds into a paste, and then subjecting the mass to pressure. It is very similar to olive oil, and is sanctioned for use in India and in the African, Eastern, and Australasian Colonies, as a substitute for the latter, in making the official hard soap, liniments, ointments, and plasters for which that oil is generally used. The oil is pale yellow or greenish-yellow in colour, with a faint nut-like odour and a bland nutty taste. It becomes turbid at 3° C., and solidifies at -5° C., while on exposure to the air it very slowly thickens and becomes rancid. It is a non-drying oil, soluble in ether or chloroform, but insoluble in alcohol. The chief constituent of arachis oil is the glyceride of oleic acid, with which are associated the glycerides of arachidic, hypogæic, lignoceric, linolic, and stearic acids. The oil has an iodine value of 92 to 100, and it contains from 1 to 10 per cent. of free fatty acids.

## Oleum Gaultheriæ.

**Oil of Gaultheria** or **Wintergreen** is obtained by distillation from the leaves of the wintergreen, *Gaultheria procumbens*, Linné (N.O. Ericaceæ), or from the bark of the sweet birch, *Betula lenta*, Linné (N.O. Betulaceæ), both plants being natives of North America. The oil possesses stimulant, diuretic, and emmenagogue properties, and is official in the North American Colonies. It is colourless or slightly yellowish in tint, with a strong characteristic odour, a warm, sweetish, aromatic taste, and a slightly acid reaction; specific gravity, 1.176 to 1.187. It is readily soluble in 90 per cent. alcohol, ether, chloroform, or glacial acetic acid. If not optically inactive, the rotation of the oil should not exceed -1.0°. Though the oils obtained from the two sources are almost identical, both consisting chiefly of methyl salicylate, the oil obtained from *G. procumbens* is distinguished by possessing a slight lævotation, while the oil of sweet birch is optically inactive. The oil does not exist ready formed in the leaves or bark, but appears to be formed in a similar manner to the oils of bitter almonds and mustard, the leaves or bark containing the glucoside gaultherin, which becomes hydrolysed by the action of a ferment named 'bétulase,' thus—



The oil from wintergreen leaves has been found to contain nearly 99 per cent. of methyl salicylate, the remaining 1 per cent. consisting of a paraffin, which melts at 65.5° C.c., and is considered to be triacontane,  $\text{C}_{30}\text{H}_{62}$ , together with small quantities of an aldehyde or ketone,  $\text{C}_6\text{H}_{10}\text{O}$ , with an odour like that of œnanthic aldehyde, an alcohol— $\text{C}_8\text{H}_{16}\text{O}$ —corresponding to the aldehyde or ketone present, and an ester,  $\text{C}_{14}\text{H}_{24}\text{O}_2$ , which yields the same alcohol and

an acid,  $C_6H_{10}O_4$ , on saponification. The oil of sweet birch has been found to contain as much as 99·8 per cent. of methyl salicylate, together with small quantities of triacontane, and an ester,  $C_{14}H_{24}O_2$ , which, on saponification, is resolved into an alcohol,  $C_8H_{16}O$ , and an acid,  $C_6H_{10}O_2$ . The alcohol (boiling point,  $160^{\circ}$ - $165^{\circ}$  C.) is the same as that found in the oil obtained from winter-green leaves, but does not occur in the free state in oil of sweet birch; the alcohol and its ester both possess very penetrating characteristic odours, which serve to distinguish the natural oils of wintergreen and sweet birch from artificial methyl salicylate, produced synthetically. [Dose.—3 to 10 minims.

### Oleum Graminis Citrati.

**Oil of Lemon Grass**, or Indian oil of verbena, is obtained by distillation from *Andropogon citratus*, De Candolle (N.O. Gramineæ), also known as *A. Schenanthus*, Wallich, a plant which is cultivated all over India. The oil (specific gravity, 0·895 to 0·905) is dark yellow in colour, with an odour resembling that of verbena. Its optical rotation should not exceed  $+3^{\circ}$  or  $-3^{\circ}$ . The oil is soluble in three parts of 70 per cent. alcohol, and should contain not less than 65 per cent. of citral and other aldehydes, as determined by the sodium hydrogen sulphite test. It possesses carminative properties, and is official in India and in the Eastern and West Indian Colonies. The principal constituent of lemon-grass oil is citral, an optically inactive aldehyde which boils between  $228^{\circ}$  and  $229^{\circ}$  C., and of which the oil may contain from 75 to 85 per cent. It also contains traces of citronellal, and possibly of an isomer of citral, together with methyl heptenone, geraniol, linalool, limonene, dipentene, and traces of cymene. [Dose.— $\frac{1}{2}$  to 3 minims.

### Oleum Gynocardia.

**Gynocardia Oil** or **Chaulmoogra Oil** is obtained by expression from the seeds of *Taraktogenus Kurzii*, King (N.O. Bixineæ), a native of Burmah. The oil possesses alterative and emetic properties, and is official in India and in the Eastern Colonies. It is officially stated that the source of chaulmoogra oil is *Gynocardia odorata*, R. Browne, or *G. Prainii*, Desprez, but the latter species does not exist, and *G. odorata* produces seeds which differ in appearance from the chaulmoogra seeds of commerce, from which the oil is obtained. The oil is brownish-yellow, of varying consistence, with a characteristic odour and a somewhat acrid taste. It has an acid reaction, and may fully liquefy only at  $42^{\circ}$  C., re-solidifying in different periods, at temperatures from  $15\cdot5^{\circ}$  C. upwards. Its specific gravity is also inconstant, but is usually from 0·930 to 0·954 at  $30^{\circ}$ - $40^{\circ}$  C. The oil is soluble in purified ether, chloroform, or carbon bisulphide, and the greater part of it is dissolved by cold 90 per cent. alcohol, the remainder being dissolved by repeated treatment with warm alcohol. A little insoluble, non-fatty matter is sometimes present in the oil, and causes turbidity of solutions in the liquids mentioned. A reddish-brown colouration, changing to olive-green, is produced on mixing twenty drops of the oil with one drop of strong sulphuric acid. The



chief constituent of the oil is chaulmoogric acid,  $C_{18}H_{32}O_2$ ; other constituents are palmitic acid, and one or more homologues of chaulmoogric acid, together with glycerides of the various acids, and phytosterol. So-called "gynocardic acid" appears to be a mixture of several substances.

[Dose.—5 to 10 minims, increasing gradually to  $\frac{1}{2}$  to 1 fluid drachm.

## Oleum Sesami.

**Sesame Oil** is obtained by expression from the seeds of *Sesamum indicum*, Linné (N.O. Pedalineæ), a native of India, which is widely cultivated for the sake of the oil. It is sometimes called "benne oil," and its use is sanctioned in India and in the African, Eastern, and North American Colonies, as a substitute for olive oil, in making the official hard soap, liniments, ointments, and plasters. It is said to be laxative in large doses, and is largely used as an emollient. The oil is limpid and of a pale yellow colour, with a faint odour and a bland taste. Specific gravity 0.921 to 0.924; it congeals at  $-5^{\circ}$  C. After shaking the oil vigorously with an equal volume of concentrated hydrochloric acid, containing about 6 per cent. of pyrogallol, the lower, acid layer, which separates on standing, should gradually become coloured when boiled for five minutes, appearing purple by transmitted light and blue by reflected light. This serves to distinguish sesame oil from olive, almond, and other oils. If sesame oil be shaken with hydrochloric acid alone, the latter will usually assume a bright emerald-green colour, especially if the oil has been exposed for some time to the action of air and light. The subsequent addition to the mixture of 10 per cent. of sugar causes the formation, after again shaking, of a blue colour, which changes to violet and, finally, to deep crimson. The chief constituent of sesame oil is about 70 per cent. of the glycerides of oleic and linolic acids; other constituents are the glycerides of palmitic, stearic, and myristic acids, a small quantity of a resinoid substance, a higher alcohol (melting point  $137^{\circ}$  C.), a crystalline substance named sesamin, and a phenolic compound named sesamol which appears to be the cause of the characteristic colour reactions of the oil.

## Oliveri Cortex.

**Oliver Bark or Black Sassafras Bark** is the dried bark of *Cinnamomum Oliveri*, Bailey (N.O. Laurineæ), a native of New South Wales and Queensland. The bark possesses aromatic, stimulant, diaphoretic, and alterative properties, and is used as an equivalent of sassafras root in the Australasian Colonies, where a tincture prepared from it is official. The drug contains tannin and a volatile oil, to which is due the spicy, camphoraceous taste of the bark, and its aromatic sassafras and camphor-like odour. The oil contains safrol, cineol, eugenol, and cinnamic aldehyde.

## Oxymel Urgineæ.

**Oxymel of Urginea.**—The process for this preparation is identical with that for Oxymel Scillæ, except that urginea replaces squill. The oxymel is official in India and in the Eastern Colonies. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

## Picrorhiza.

**Picrorhiza** consists of the dried rhizome of *Picrorhiza Kurroa*, Royle (N.O. Scrophularineæ), a plant found in the Alpine Himalaya, from Cashmere to Sikkim. The rhizome is used as a bitter tonic, aperient, and antiperiodic in India and the Eastern Colonies, a liquid extract and a tincture being official in those countries. The chief constituent of the drug is the bitter, crystalline glucoside picrorhizin, which yields picrorhizetin and dextrose on hydrolysis; other constituents are organic acid, wax, and gum. Tannin is absent. Picrorhizin is acid in reaction and freely soluble in water or alcohol, but almost insoluble in pure ether. Picrorhizetin is a tasteless, reddish-brown, brittle, resinous body, which is soluble in aqueous alkalies, and evolves an odour resembling that of benzoin when heated with strong sulphuric acid.

[Dose.—10 to 20 grains (tonic); 40 to 50 grains (antiperiodic).]

## Pilulæ.

**Pills.**—There are only two formulæ for pills in the Addendum, and both are official in India and the Eastern Colonies, where the pills may be used as equivalents of the corresponding preparations of squill.

**Pilula Ipecacuanhæ cum Urginea.** PILL OF IPECACUANHA WITH URGINEA.

This pill contains about 5 per cent. of opium, the formula being identical with that for *Pilula Ipecacuanhæ cum Scilla*, except that *urginea* replaces squill.

[Dose.—4 to 8 grains.]

**Pilula Urgineæ Composita.** COMPOUND URGINEA PILL.

The formula is identical with that for *Pilula Scillæ Composita*, except that *urginea* replaces squill.

[Dose.—4 to 8 grains.]

## Podophylli Indici Resina.

**Indian Podophyllum Resin** is prepared from Indian podophyllum rhizome by the same process as that by which Podophylli Resina is prepared from American podophyllum. The resin possesses alterative, cholagogue, and cathartic properties. It is used in India and the Eastern Colonies as a substitute for ordinary podophyllum resin, the two resins containing the same constituents (see page 365). The active constituents of the resin are podophyllotoxin and podophylloresin, which are associated with inactive podophyllic acid and picropodophyllin, together with quercetin and fatty matter. The active constituents are present in greater proportion than in the resin of American podophyllum. The Indian resin is said to produce an orange to red colour when a minute quantity is sprinkled on strong sulphuric acid, while the American resin produces a yellow to brown colour when similarly treated. It is also stated that a semi-solid gelatinous mass results on shaking together, in a test-tube, 0.4 Gm. of the Indian resin (or the residue left on evaporating 20 C.c. of tincture to dryness), 3 C.c. of diluted alcohol (specific gravity 0.920), and 0.5 C.c. of potassium hydroxide solution; if necessary, the mixture should

be heated to boiling point and then cooled. In the case of the American podophyllum resin (or a tincture prepared therefrom), when similarly treated, the mixture is said to show no signs of gelatinising. [Dose.— $\frac{1}{4}$  to 1 grain.

## Podophylli Indici Rhizoma.

**Indian Podophyllum Rhizome** consists of the dried rhizome and roots of *Podophyllum Emodi*, Wallich (N.O. Berberidæ), a native of Northern India. The drug possesses alterative, cholagogue, and cathartic properties. It is used as an equivalent of American podophyllum rhizome in India and the Eastern Colonies, the resin and tincture prepared from it being official in those countries. Indian podophyllum yields from 6 to 12 per cent. of resin, the constituents of which are practically identical with those of *P. peltatum*. Other constituents of the drug are starch and sugar. The resin is said to be twice as active, physiologically, as ordinary podophyllum resin, owing to the presence of a larger proportion of the two active constituents—podophyllotoxin and podophylloresin.

## Pulveres.

**Powders.**—The two powders in the Addendum are official in India and the Eastern Colonies.

**Pulvis Buteæ Seminum.** POWDER OF BUTEA SEEDS.

Butea seeds are soaked in water, their integuments removed, and the kernels dried and powdered. [Dose.—10 to 20 grains.

**Pulvis Kaladanæ Compositus.** COMPOUND POWDER OF KALADANA.

The formula for this preparation is identical with that for Pulvis Jalapæ Compositus, except that kaladana replaces jalap. [Dose.—20 to 60 grains.

## Sappan.

**Sappan** is the heart-wood of *Cæsalpinia Sappan*, Linné (N.O. Leguminosæ), a native of India. The wood possesses astringent properties, and is used in India and the Eastern Colonies as an equivalent of logwood, a decoction of the drug being official in the Indian and Colonial Addendum. The colouring principle of sappan wood is a crystalline body named sappanin, which closely resembles hæmatoxylin and was formerly supposed to be identical with brazilin, though that is now known to be incorrect. Sappanin forms colourless crystals, which become orange-coloured on exposure to air, and give a carmine-red colouration with alkalis, owing to the formation of a body like brazilin by oxidation, just as in the case of brazilin. Hæmatoxylin is converted into purplish hæmatein, under similar conditions.

## Succi.

**Juices.**—The two juices included in the Addendum are official in India and the Eastern Colonies.



**Succus Acalyphæ.** JUICE OF ACALYPHA.

The juice is extracted by the same process as Succus Scoparii, fresh acalypha replacing broom tops. [Dose.—1 to 4 fluid drachms.

**Succus Adhatodæ.** JUICE OF ADHATODA.

The freshly-expressed and strained juice of the bruised fresh leaves of *Adhatoda vasica*, Nees. [Dose.—1 to 4 fluid drachms.

## Suppositoria.

**Suppositories.**—In India and the Colonies, more or less white beeswax may be used in making the official suppositories, in place of an equivalent amount of oil of theobroma, when prevailing high temperatures would otherwise cause the suppositories to be too soft for convenient use.

## Syrupi.

**Syrups.**—There is only one syrup official in the Addendum, but the use of an increased proportion of alcohol is sanctioned in the case of Syrupus Rhœados.

**Syrupus Rhœados.** SYRUP OF RED POPPY.

The proportion of 90 per cent. alcohol in this preparation may be increased, in India and the Colonies, when prevailing high temperatures render this preparation liable to ferment, an equivalent quantity of water being omitted and the proportion of alcohol not exceeding twice that specified in the official formula. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Syrupus Urgineæ.** SYRUP OF URGINEA.

Is prepared by the same process as Syrupus Scillæ, except that vinegar of urguinea replaces vinegar of squill. The syrup is official in India and the Eastern Colonies, where it is used as an equivalent of syrup of squill. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

## Tincturæ.

**Tinctures.**—There are eighteen tinctures official in the Addendum, the formulæ for all but Tinctura Jalapæ Composita being practically identical with those for tinctures official in the Pharmacopœia.

**Tinctura Adhatodæ.** TINCTURE OF ADHATODA.

Process as that for Tinctura Digitalis, except that dried adhatoda in No. 40 powder replaces digitalis leaves. Strength, 1 in 8. India and the Eastern Colonies. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Alstoniæ.** TINCTURE OF ALSTONIA.

Process as that for Tinctura Croci, except that alstonia in No. 20 powder replaces saffron, and the strength is 1 in 8. India and the Australasian and Eastern Colonies. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Andrographidis.** TINCTURE OF ANDROGRAPHIS.

Process as that for Tinctura Chiratae, andrographis replacing chiretta.  
Strength, 1 in 10. India and the Eastern Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Aristolochiae.** TINCTURE OF ARISTOLOCHIA.

Process as that for Tinctura Serpentariae, aristolochia replacing serpentry rhizome. Strength, 1 in 5. India and the Eastern Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Arnicae Florum.** TINCTURE OF ARNICA FLOWERS.

Process as that for Tinctura Hamamelidis, arnica flowers replacing hamamelis bark. Strength, 1 in 10. North American Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Azadirachtæ Indicae.** TINCTURE OF INDIAN AZADIRACH.

Process as that for Tinctura Quassiae, except that Indian azadirach replaces quassia wood. Strength 1 in 10. India and the Eastern Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Berberidis.** TINCTURE OF BERBERIS.

Process as that for Tinctura Hydrastis, berberis replacing hydrastis rhizome. Strength, 1 in 10. India and the Eastern Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Calotropis.** TINCTURE OF CALOTROPIS.

Process as that for Tinctura Cimicifugae, calotropis replacing cimicifuga. Strength, 1 in 10. India and the Eastern Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Coccinii.** TINCTURE OF COSCINIUM.

Process as that for Tinctura Calumbae, coccinium replacing calumba root. Strength, 1 in 10. India and the Eastern Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Daturæ Semen.** TINCTURE OF DATURA SEEDS.

Process as that for Tinctura Cinnamomi, except that bruised datura seeds replace cinnamon bark and the strength is 1 in 4. India and the Eastern Colonies.

[Dose.—5 to 15 minims.

**Tinctura Jalapæ Composita.** COMPOUND TINCTURE OF JALAP.

Jalap, in No. 40 powder, 8; scammony, in No. 40 powder, 2; turpeth, in No. 40 powder, 1. The mixed powders are moistened with 60 per cent. alcohol, and percolated with more alcohol until a tincture is obtained of such strength that 12.5 fluid parts represent 1 part of jalap. India and Eastern and North American Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Kaladanæ.** TINCTURE OF KALADANA.

Process as that for Tinctura Pyrethri, kaladana replacing pyrethrum root. Strength, 1 in 5. India and the Eastern Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Oliveri Corticis.** TINCTURE OF OLIVER BARK.

Process as that for Tinctura Gelsemii, oliver bark replacing gelsemium root. Strength, 1 in 10. Australasian Colonies.

[Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Picrorhizæ.** TINCTURE OF PICRORHIZA.

Process as that for Tinctura Cocci, except that picrorhiza, cut small and well bruised, replaces cochineal, and the strength is 1 in 8. India and the Eastern Colonies. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Podophylli Indici.** TINCTURE OF INDIAN PODOPHYLLUM.

Process as that for Tinctura Podophylli, except that Indian podophyllum resin replaces American. Strength, 1 in 27·4. India and the Eastern Colonies. [Dose.—5 to 15 minims.

**Tinctura Tinospora.** TINCTURE OF TINOSPORA.

Process as that for Tinctura Calumbæ, except that tinospora replaces calumba root, and the strength is 1 in 5. India and the Eastern Colonies. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

**Tinctura Urgineæ.** TINCTURE OF URGINEA.

Process as that for Tinctura Scillæ, urguinea replacing squill. Strength 1 in 5. India and the Eastern Colonies. [Dose.—5 to 15 minims.

**Tinctura Valerianæ Indicæ Ammoniata.** AMMONIATED TINCTURE OF INDIAN VALERIAN.

Process as that for Tinctura Valerianæ Ammoniata, except that Indian valerian replaces valerian rhizome. Strength, 1 in 5. India and the Eastern Colonies. [Dose.— $\frac{1}{2}$  to 1 fluid drachm.

## Tinospora.

**Tinospora** is the dried stem of *Tinosopora cordifolia*, Miers (N.O. Menispermaceæ), a native of tropical India. The drug possesses tonic, alterative, diuretic, and antiperiodic properties. It is known as “gulancha,” and is used in India and the Eastern Colonies as an equivalent of calumba root, an infusion, concentrated solution (liquor), and tincture being official. Tinospora contains berberine, starch, and an amorphous bitter glucoside. An extract of the drug, known in India as “palo,” or “sat-i-giloe,” consists of starch retaining a little of the bitterness of the drug.

## Toddalia.

**Toddalia** consists of the dried root-bark of *Toddalia aculeata*, Persoon (N.O. Rutaceæ), a native of India and Ceylon. The drug possesses bitter tonic and stomachic properties, and is used in India and the Eastern Colonies as an equivalent of cusparia bark, an infusion and concentrated solution (liquor) being official. The drug contains a yellow resin, a bitter principle, and a green volatile oil having the odour of citron peel and a bitter, aromatic taste.

## Turpethum.

**Turpeth** consists of the dried root and stem of *Ipomœa Turpethum*, R. Brown (N.O. Convolvulaceæ), a plant found growing throughout India and Ceylon.



It possesses hepatic, stimulant, and hydragogue cathartic properties, and is used in India and the Eastern and North American Colonies as an equivalent of jalap, while the powdered drug is one of the ingredients of *Tinctura Jalapæ Composita*. The drug contains about 10 per cent. of resin, the chief constituent of which is turpethin, a glucosidal resin, soluble in alcohol but insoluble in ether. It resembles jalapin (convolvulin) in its reactions, yields turpetholic acid and glucose on hydrolysis with dilute acids, and is converted into turpethic acid by the action of strong alkalis. Other constituents of the drug are a soft resin soluble in ether, a volatile oil, fatty matter, albumin, starch, yellow colouring matter, etc. Turpeth resin is supposed to resemble turpeth mineral (basic mercuric sulphate) in colour and action. [Dose.—5 to 20 grains.

## Tylophoræ Folia.

**Tylophora Leaves** are obtained from *Tylophora asthmatica*, Wight et Arnott (N.O. Asclepiadaceæ), a native of India and Ceylon. The dried leaves possess expectorant, diaphoretic, and emetic properties. They are used as an equivalent of ipecacuanha in India and the Eastern Colonies, and are usually administered in the form of powder. The drug contains about 15 per cent. of mineral matter, a crystalline alkaloid named tylophorine, and an emetic principle. [Dose.— $\frac{1}{4}$  to 2 grains (expectorant); 15 to 30 grains (emetic).

## Unguenta.

**Ointments.**—In India and the Colonies, more or less indurated lard, prepared suet, and yellow or white beeswax may be employed in the preparation of special ointments, when prevailing high temperatures otherwise render the basis too soft for convenient use, but the official proportion of active ingredient must in all cases be maintained. Three of the four ointments included in the Addendum may be thus modified, the exception being Unguentum Gynocardia, which is prepared with a special paraffin basis.

### Unguentum Gynocardia. GYNOCARDIA OINTMENT.

Gynocardia oil, 5, is added to a melted mixture of hard paraffin, 20, and white soft paraffin, 25, the ointment being stirred until cold. India and the Eastern Colonies.

### Unguentum Mylabridis. MYLABRIS OINTMENT.

Formula as that for Unguentum Cantharidis, except that mylabris replaces cantharides, and benzoated suet may be used in India instead of benzoated lard. Strength, 1 to 10. India and the African and Eastern Colonies.

### Unguentum Myrobalani. MYROBALAN OINTMENT.

Formula as that for Unguentum Gallæ, except that myrobalans replace galls, and benzoated suet may be used in India instead of benzoated lard. Strength, 1 in 5. India and the Eastern Colonies.

**Unguentum Myrobalani cum Opio.** MYROBALAN AND OPIUM OINTMENT.

This ointment contains 7.5 per cent. of opium. The formula is the same as that for Unguentum Gallæ cum Opio, except that myrobalan ointment replaces gall ointment. India and the Eastern Colonies.

## Urginea.

**Urginea** or **Indian Squill** consists of the younger bulbs of *Urginea indica*, Kunth (N.O. Liliaceæ), or of *Scilla indica*, Baker (N.O. Liliaceæ), also known as *Ledebouria hyacinthina*, Roth, both plants being natives of India. The bulbs should be collected soon after the plant has flowered, and be kept in a dry place. They contain bitter principles similar to those found in ordinary squill. The drug possesses stimulant, expectorant, and diuretic properties, and is used as an equivalent of ordinary squill in India and the Eastern Colonies, several preparations of the drug being official.

## Valerianæ Indicæ Rhizoma.

**Indian Valerian Rhizome** consists of the dried rhizome and rootlets of *Valeriana Wallichii*, De Candolle (N.O. Valerianæ), a plant found in the temperate Himalaya. The drug is known as "tagar"; it has the odour characteristic of valerian rhizome, but in a much more powerful degree, and possesses stimulant and antispasmodic properties. It is used in India and the Eastern Colonies as an equivalent of ordinary valerian, an ammoniated tincture of the drug being official. The most important constituent of the drug is a volatile oil resembling that of *V. officinalis*, but it also contains valerianic and other organic acids, resin, tannin, wax, and other plant principles.

## Viburnum.

**Black Haw** consists of the dried bark of *Viburnum prunifolium*, Linné (N.O. Caprifoliaceæ), a plant which is very common in the Middle and Southern United States. The bark possesses astringent, antispasmodic, diuretic, tonic, and nervine properties. It is used in India and the Eastern and North American Colonies, a liquid extract being official. The drug contains a water-soluble bitter glucoside named viburnin, a brown bitter resin, valerianic (viburnic) and other organic acids, tannin, sugar, etc. It has also been stated to contain an alkaloid, but that statement requires confirmation.



# Names, Symbols, and Atomic Weights of the Chief Elements mentioned in the British Pharmacopœia ; H = 1.00.

Name.	Symbol.	Atomic Weight.
Aluminium . . . .	Al . . . .	26.90
Antimony . . . .	Sb . . . .	119.00
Arsenium . . . .	As . . . .	74.50
Barium . . . .	Ba . . . .	136.40
Bismuth . . . .	Bi . . . .	207.30
Boron . . . .	B . . . .	10.85
Bromine . . . .	Br . . . .	79.35
Calcium . . . .	Ca . . . .	39.71
Carbon . . . .	C . . . .	11.91
Cerium . . . .	Ce . . . .	139.20
Chlorine . . . .	Cl . . . .	35.19
Chromium . . . .	Cr . . . .	51.74
Copper . . . .	Cu . . . .	63.12
Gold . . . .	Au . . . .	195.70
Hydrogen . . . .	H . . . .	1.00
Iodine . . . .	I . . . .	125.90
Iron . . . .	Fe . . . .	55.60
Lead . . . .	Pb . . . .	205.35
Lithium . . . .	Li . . . .	6.97
Magnesium . . . .	Mg . . . .	24.18
Manganese . . . .	Mn . . . .	54.52
Mercury . . . .	Hg . . . .	198.80
Nitrogen . . . .	N . . . .	13.94
Oxygen . . . .	O . . . .	15.88
Phosphorus . . . .	P . . . .	30.80
Platinum . . . .	Pt . . . .	193.30
Potassium . . . .	K . . . .	38.83
Silver . . . .	Ag . . . .	107.11
Sodium . . . .	Na . . . .	22.88
Sulphur . . . .	S . . . .	31.82
Tin . . . .	Sn . . . .	118.20
Zinc . . . .	Zn . . . .	64.91

NOTE.—The above table, which appears in an Appendix to the British Pharmacopœia, is based upon hydrogen taken as unity. If oxygen be taken as 16, the atomic weights of most of the other elements will become so nearly equivalent to whole numbers that such whole numbers may be used in commercial analysis, without introducing variations approaching in value those due to experimental error. The official table, including numbers carried to the second decimal place, may be considered unnecessarily refined for ordinary purposes; but inasmuch as this table is used in the official monographs, it has also been employed in ‘Pharmacopœia,’ so as to render comparable the figures and constants under discussion.



# Weights and Measures of the Imperial System.

## Measures of Length.

1 Inch	in.		
1 Foot	ft.	=	12 inches.
1 Yard	yd.	=	36 inches.

### IMPERIAL TO METRIC.

Inches	÷	0.039	=	Millimetres.	Inches	×	0.254	=	Decimetres.
Inches	×	25.399	=	Millimetres.	Inches	÷	39.370	=	Metres.
Inches	÷	0.394	=	Centimetres.	Inches	×	0.025	=	Metres.
Inches	×	2.539	=	Centimetres.	Miles	÷	0.621	=	Kilometres.
Inches	÷	3.937	=	Decimetres.	Miles	×	1.609	=	Kilometres

## Measures of Mass.

1 Grain	gr.		
1 Ounce (Avoir.)	oz.	=	437.5 grains.
1 Pound	lb.	=	16 Ounces = 7,000 grains.

### IMPERIAL TO METRIC.

Grains	÷	15.432	=	Gms.	Ounces (Troy)	×	31.104	=	Gms.
Grains	×	0.065	=	Gms.	Ounces (Avoir.)	÷	0.035	=	Gms.
Scruples (Apoth.)	×	1.296	=	Gms.	Ounces (Avoir.)	×	28.350	=	Gms.
Drachms(Apoth.)	×	3.888	=	Gms.	Pounds (Avoir.)	÷	2.205	=	Kilo.
Ounces (Troy)	÷	0.032	=	Gms.	Pounds (Avoir.)	×	0.454	=	Kilo

## Measures of Capacity.

1 Minim	min.		
1 Fluid Drachm	fl. drm.	=	60 minims.
1 Fluid Ounce	fl. oz.	=	8 fluid drachms.
1 Pint	O.	=	20 fluid ounces
1 Gallon	C.	=	8 pints.

### IMPERIAL TO METRIC.

Minims	÷	16.894	=	Millilitres.	Ounces (fl.)	÷	35.196	=	Litres.
Minims	×	0.059	=	Millilitres.	Ounces (fl.)	×	0.028	=	Litres.
Drachms (fl.)	÷	0.282	=	Millilitres.	Pints	÷	1.759	=	Litres.
Drachms (fl.)	×	3.552	=	Millilitres.	Pints	×	0.568	=	Litres.
Ounces (fl.)	×	28.412	=	Millilitres.	Gallons	÷	0.219	=	Litres.
Ounces (fl.)	÷	0.035	=	Millilitres.	Gallons	×	4.545	=	Litres.

## Relation of Volume to Mass.

1 Minim	is the volume at 62° F. of	0.9114583	grain of water.
1 Fluid Drachm	" " "	54.6875	grains of water.
1 Fluid Ounce	" 1 ounce or	437.5	grains of water.
1 Pint	" 1.25 pounds or	8,750.0	grains of water.
1 Gallon	" 10 pounds or	70,000.0	grains of water.
109.7143 minims*	= the volume at 62° F. of	100	grains of water.

\* Taken as 110 minims throughout the British Pharmacopœia.

# Weights and Measures of the Metric System.

## Measures of Length.

1 Micromillimetre or Micron ( $\mu$ )	=	0.001 Mm.	=	0.0000394 Inch.
1 Millimetre (Mm.)	=	0.001 M.	=	0.0393701 Inch.
1 Centimetre (Cm.)	=	0.010 M.	=	0.3937011 Inch.
1 Decimetre (Dm.)	=	0.100 M.	=	3.9370113 Inches.
1 Metre (M.)	=	1.0 M.	=	$\left\{ \begin{array}{l} 39.370113 \text{ Inches.} \\ 3.280843 \text{ Feet.} \\ 1.0936143 \text{ Yards.} \end{array} \right.$
1 Dekametre (Dkm.)	=	10.0 M.	=	109.3614 Yards.
1 Hectometre (Hm.)	=	100.0 M.	=	1093.6143 Yards.
1 Kilometre (Km.)	=	1,000.0 M.	=	0.62137 Mile.
1 Myriametre (Mym.)	=	10,000.0 M.	=	6.21371 Miles.

## METRIC TO IMPERIAL.

Millimetres	$\times$	0.039	=	Inches.	Decimetres	$\div$	0.254	=	Inches.
Millimetres	$\div$	25.399	=	Inches.	Metres	$\times$	39.370	=	Inches.
Centimetres	$\times$	0.394	=	Inches.	Metres	$\div$	0.025	=	Inches.
Centimetres	$\div$	2.539	=	Inches.	Kilometres	$\times$	0.621	=	Miles.
Decimetres	$\times$	3.937	=	Inches.	Kilometres	$\div$	1.609	=	Miles.

## Measures of Mass.

1 Milligramme (Mgm.)	=	0.001 Gm.	=	0.015 Grain.
1 Centigramme (Cgm.)	=	0.010 Gm.	=	0.154 Grain.
1 Decigramme (Dgm.)	=	0.100 Gm.	=	1.543 Grain.
1 Gramme (Gm.)	=	1.0 Gm.	=	$\left\{ \begin{array}{l} 15.432 \text{ Grains.} \\ 0.7716 \text{ Scruple.} \\ 0.2572 \text{ Drachm.} \\ 0.03215 \text{ Oz. Troy.} \\ 0.03527 \text{ Oz. (Avoir.)} \end{array} \right.$
1 Dekagramme (Dkgm.)	=	10.0 Gm.	=	5.644 Drachms.
1 Hectogramme (Hgm.)	=	100.0 Gm.	=	3.5274 Ounces.
1 Kilogramme (Kilo.)	=	1,000.0 Gm.	=	$\left\{ \begin{array}{l} 2.2046 \text{ Lbs. or} \\ 15432.3564 \text{ Grains.} \end{array} \right.$
1 Myriagramme (Mygm.)	=	10.0 Kilo.	=	22.0462 Lbs.
1 Quintal (Q.)	=	100.0 Kilo.	=	1.9681 Cwt.
1 Millier or Tonne (T.)	=	1,000.0 Kilo.	=	0.9842 Ton.

## METRIC TO IMPERIAL.

Grammes	$\times$	15.432	=	Grains.	Grammes	$\div$	31.104	=	Ounces (Troy)
Grammes	$\div$	0.065	=	Grains.	Grammes	$\times$	0.035	=	Ounce (Avoir.)
Grammes	$\times$	1.296	=	Scruple (Apoth.)	Grammes	$\div$	28.350	=	Ounces (Avoir.)
Grammes	$\div$	3.888	=	Drachms (Apoth.)	Kilogramme	$\times$	2.205	=	Pounds (Avoir.)
Grammes	$\times$	0.032	=	Ounce (Troy)	Kilogramme	$\div$	0.454	=	Pounds (Avoir.)

## Measures of Capacity.

1 Microlitre (Mcl.)	=	0.001 Ml.	=	0.0169 Minim.
1 Mil or Millilitre (Ml.)	=	0.001 L.	=	0.0352 Fluid Ounce.
1 Centilitre (Cl.)	=	0.010 L.	=	0.0176 Pint.
1 Decilitre (Dl.)	=	0.100 L.	=	0.1759 Pint.
1 Litre (L.)	=	1.0 L.	=	1.7598 Pints.
1 Dekalitre (Dkl.)	=	10.0 L.	=	2.19975 Gallons.
1 Hectolitre (Hl.)	=	100.0 L.	=	2.74969 Bushels.
1 Kilolitre (Kl.)	=	1000.0 L.	=	3.43712 Quarters.

## METRIC TO IMPERIAL.

Millilitres	$\times$	16.894	=	Minims.	Litres	$\times$	35.196	=	Ounces (Fl.)
Millilitres	$\div$	0.059	=	Minims.	Litres	$\div$	0.028	=	Ounces (Fl.)
Millilitres	$\times$	0.282	=	Drachms (Fl.)	Litres	$\times$	1.759	=	Pints.
Millilitres	$\div$	3.552	=	Drachms (Fl.)	Litres	$\div$	0.568	=	Pints.
Millilitres	$\times$	0.035	=	Ounces (Fl.)	Litres	$\times$	0.219	=	Gallons.
Millilitres	$\div$	28.412	=	Ounces (Fl.)	Litres	$\div$	4.545	=	Gallons.

## Cubic Measures and Measures of Capacity.

1 Cubic Centimetre (1 C.c.)	=	0.99984 Millilitre.	1 Cubic Decimetre (1,000 C.c.)	=	0.99984 Litre.
1.00016 C. Centimetre	=	1.0 Millilitre.	1.00016 C. Decimetre	=	1.0 Litre.

# Equivalents of Measures of Length.

Metric.	Imperial.	Metric.	Imperial.	Metric.	Imperial.
Millimetres.	Inches.	Millimetres.	Inches.	Millimetres.	Inches.
1524	60	533	21	19	0.75
1500	59.06	508	20	18	0.71
1450	57.09	500	19.69	17.5	0.69
1400	55.12	483	19	17	0.67
1397	55	457	18	16	0.63
1350	53.15	450	17.72	15	0.59
1300	51.18	432	17	14	0.55
1270	50	406	16	13	0.51
1250	49.21	400	15.75	12.5	0.49
1200	47.24	381	15	12	0.47
1150	45.28	356	14	11	0.43
1143	45	350	13.78	10 (1 Cm.)	0.39
1100	43.31	330	13	9.5	0.37
1050	41.34	305	12 (1 Foot)	9	0.35
1016	40	300	11.81	8.5	0.33
1000 (1 M.)	39.37	279	11	8	0.31
990	39	254	10	7.5	0.29
965	38	250	9.84	7	0.28
950	37.40	229	9	6.5	0.25
939	37	203	8	6	0.24
914	36 (1 Yard)	200	7.87	5.5	0.22
900	35.43	178	7	5	0.20
889	35	152	6	4.5	0.18
864	34	150	5.91	4	0.16
850	33.46	127	5	3.5	0.14
838	33	102	4	3	0.12
813	32	100 (1 Dcm.)	3.94	2.5	0.10
800	31.50	90	3.54	2	0.08
787	31	80	3.15	1.75	0.07
762	30	76	3	1.5	0.06
750	29.53	70	2.76	1.25	0.05
736	29	60	2.36	1	0.04
711	28	51	2	0.9	0.035
700	27.56	50	1.97	0.8	0.031
686	27	40	1.57	0.75	0.029
660	26	30	1.18	0.7	0.027
650	25.59	25.4	1	0.6	0.023
635	25	25	0.98	0.5	0.019
610	24	24	0.94	0.4	0.015
600	23.62	23	0.90	0.3	0.012
584	23	22	0.87	0.25	0.0097
559	22	21	0.83	0.2	0.0078
550	21.65	20	0.79	0.1	0.0039



# Equivalents of Measures of Mass.

Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.
Grammes.	Grains.	Grammes.	Grains.	Grammes.	Grains.
<b>1000</b>	15432.4	<b>475</b>	7330.4	<b>50</b>	771.6
995.312	15360	466.552	7200	45.359	700
<b>975</b>	15046.6	453.592	7000 [1 av. lb.	<b>40</b>	617.3
971.984	15000	<b>450</b>	6944.6	39.879	600
964.208	14880	435.449	6720	32.399	500
<b>950</b>	14660.7	425.243	6562.5	31.1035	<b>480</b> [1 3]
933.105	14400	<b>425</b>	6558.8	<b>31</b>	478.4
<b>925</b>	14274.9	404.345	6240	30.455	<b>470</b>
907.185	14000 [2 av. lbs.	<b>400</b>	6172.9	<b>30.5</b>	470.7
902.000	13920	396.893	6125	<b>30</b>	463.0
<b>900</b>	13889.1	388.794	6000	29.807	<b>460</b>
878.635	13562.5	<b>375</b>	5787.1	<b>29.5</b>	455.3
<b>875</b>	13503.3	373.242	5760 [1 troy lb.	29.159	<b>450</b>
870.898	13440	368.544	5687.5	<b>29</b>	447.5
850.486	13125	<b>350</b>	5401.3	28.512	440
<b>850</b>	13117.5	342.138	5280	<b>28.5</b>	439.8
842.386	13000	340.194	5250	28.350	<b>437.5</b> [1 av. oz.
839.794	12960	<b>325</b>	5015.5	<b>28</b>	431.1
<b>825</b>	12731.7	323.995	5000	27.864	<b>430</b>
822.136	12687.5	311.845	4812.5	<b>27.5</b>	423.4
808.691	12480	311.035	4800	27.215	<b>420</b> [7 3]
<b>800</b>	12345.9	<b>300</b>	4629.7	<b>27</b>	416.7
793.787	12250	283.495	4375	26.568	<b>410</b>
777.587	12000	279.930	4320	<b>26.5</b>	408.3
<b>775</b>	11960.1	<b>275</b>	4244	<b>26</b>	401.2
765.437	11812.5	259.196	4000	25.919	<b>400</b>
<b>750</b>	11574.3	255.146	3937.5	<b>25.5</b>	393.5
746.484	11520 [2 troy lbs.	<b>250</b>	3858.1	25.271	<b>390</b>
737.087	11375	248.828	3840	<b>25</b>	385.8
<b>725</b>	11188.5	226.796	3500	24.624	<b>380</b>
715.380	11040	<b>225</b>	3472.3	24.5	378.1
712.788	11000	217.724	3360	<b>24</b>	370.4
708.738	10937.5	<b>200</b>	3086.5	23.976	<b>370</b>
<b>700</b>	10802.6	198.447	3062.5	<b>23.5</b>	362.7
684.277	10560	194.397	3000	23.327	<b>360</b> [6 3]
680.388	10500	186.621	2880	<b>23</b>	354.9
<b>675</b>	10416.8	<b>175</b>	2700.7	22.679	<b>350</b>
653.173	10080	170.097	2625	<b>22.5</b>	347.2
652.039	10062.5	161.997	2500	22.032	<b>340</b>
<b>650</b>	10031.0	155.517	2400	<b>22</b>	339.5
647.989	10000	<b>150</b>	2314.9	21.5	331.8
<b>625</b>	9645.2	141.748	2187.5	21.383	<b>330</b>
623.689	9625	129.598	2000	<b>21</b>	324.1
622.070	9600	<b>125</b>	1929	20.736	<b>320</b>
<b>600</b>	9259.4	124.414	1920	20.5	316.4
595.340	9187.5	113.398	1750	20.088	<b>310</b>
590.966	9120	<b>100</b>	1543.2	<b>20</b>	308.6
583.191	9000	97.198	1500	19.5	300.9
<b>575</b>	8873.6	93.310	1440	19.439	<b>300</b> [5]
566.900	8750	<b>90</b>	1388.9	<b>19</b>	293.2
559.863	8640	85.049	1312.5	18.792	<b>290</b>
<b>550</b>	8487.8	<b>80</b>	1234.6	18.5	285.5
538.641	8312.5	75	1157.4	18.144	<b>280</b>
528.759	8160	<b>70</b>	1080.3	18	277.8
<b>525</b>	8102	64.799	1000	17.5	270.1
518.392	8000	62.207	960	17.495	<b>270</b>
510.291	7875	<b>60</b>	925.9	<b>17</b>	262.3
<b>500</b>	7716.2	58.319	900	16.848	<b>260</b>
497.656	7680	56.699	875	16.5	254.6
481.942	7437.5	51.839	800	16.109	<b>250</b>

Equivalents of Measures of Mass—*continued.*

Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.	Metric Weight.	Imperial Weight.
Grammes.	Grains.	Gramme.	Grains.	Gramme.	Grains.
16	246.9	4.212	65	0.259	4
15.878	245	4	61.7	0.25	3.9
15.551	240 4 3	3.888	60	0.226	3.5
15.5	239.2	3.564	55	0.2	3.1
15.228	235	3.544	54.6875 [ $\frac{1}{8}$ av. oz.]	0.194	3
15	231.5	3.5	54.0	0.162	2.5
14.904	230	3.240	50	0.15	2.3
14.580	225	3	46.3	0.129	2
14.5	223.8	2.916	45	0.125	1.9
14.256	220	2.592	40	0.10	1.55
14.175	218.75 [ $\frac{1}{2}$ av. oz.]	2.5	38.6	0.097	1.5
14	216.1	2.268	35	0.06479	1
13.932	215	2	30.9	0.061	0.94
13.607	210	1.944	30 [ $\frac{1}{2}$ 3]	0.060	0.93
13.5	208.4	1.9	29.3	0.057	0.88
13.284	205	1.8	27.8	0.053	0.82
13	200.6	1.75	27.0	0.052	0.77
12.690	200	1.7	26.2	0.049	0.76
12.636	195	1.620	25	0.046	0.7
12.5	192.9	1.6	24.7	0.045	0.69
12.312	190	1.555	24	0.044	0.66
12	185.2	1.5	23.2	0.040	0.62
11.988	185	1.490	23	0.039	0.6
11.663	180 3 3	1.426	22	0.036	0.56
11.5	177.5	1.4	21.6	0.032	0.5
11.340	175	1.361	21	0.029	0.45
11.016	170	1.3	20.1	0.028	0.43
11	169.8	1.296	20 [ $\frac{1}{2}$ 9]	0.026	0.4
10.692	165	1.25	19.3	0.024	0.37
10.5	162.1	1.232	19	0.023	0.35
10.368	160	1.2	18.5	0.022	0.33
10	154.3	1.166	18	0.020	0.31
10.044	155	1.102	17	0.019	0.3
9.719	150	1.1	16.9	0.016	0.25
9.5	146.6	1.037	16	0.013	0.2
9.396	145	1	15.4324	0.012	0.18
9.072	140	0.972	15	0.011	0.166
9	138.6	0.95	14.7	0.009	0.15
8.748	135	0.907	14	0.008	0.125
8.5	130.9	0.9	13.9	0.0090	0.1428571
8.424	130	0.85	13.1	0.0070	0.11
8.100	125	0.842	13	0.0065	0.1
8	123.5	0.8	12.4	0.0055	0.0833
7.775	120 2 3	0.775	12	0.0040	0.06
7.5	115.8	0.75	11.6	0.0032	0.05
7.452	115	0.713	11	0.0028	0.04166
7.128	110	0.7	10.8	0.0027	0.04
7.088	109.375 [ $\frac{1}{4}$ av. oz.]	0.65	10.1	0.0022	0.033
7	108.0	0.648	10 [ $\frac{1}{2}$ 9]	0.0020	0.032
6.804	105	0.6	9.1	0.0018	0.028
6.5	100.3	0.583	9	0.0016	0.025
6.480	100	0.55	8.5	0.0014	0.020833
6.156	95	0.518	8	0.0013	0.02
6	92.6	0.5	7.7	0.0011	0.017
5.832	90	0.454	7	0.0010	0.015
5.505	85	0.45	6.9	0.0007	0.0104166
5.5	84.9	0.4	6.2	0.0006	0.01
5.184	80	0.389	6	0.0005	0.008
5	77.2	0.35	5.4	0.0004	0.0065
4.860	75	0.324	5	0.0003	0.005
4.536	70	0.3	4.6	0.0002	0.003
4.5	69.5	0.291	4.5	0.0001	0.0015

# Equivalents of Measures of Capacity.

Metric Measure.			Imperial Measure.		
Millilitres.	Minims.	Fluid Grains.	Millilitres.	Minims.	Fluid Grains.
1000 (1 litre)	16894·1	15398·3	500	8447	7699·1
994·429	16800 [35 fl. oz.	15312·5	483·009	8160 [17 fl. oz.	7437·5
975	16471·7	15013·3	475	8024·7	7314·2
966·017	16320 [34 fl. oz.	14875	471·536	8000	7291·7
950	16049·4	14628·3	454·596	7680 [16 fl. oz.	7000
947·072	16000	14583·4	450	7602·4	6929·2
937·605	15840 [33 fl. oz.	14437·5	426·184	7200 [15 fl. oz.	6562·5
925	15627	14243·4	425	7179·9	6544·3
909·193	15360 [32 fl. oz.	14000	414·344	7000	6380·2
900	15204·7	13858·4	400	6757·6	6159·5
887·883	15·000	13671·9	397·772	6720 [14 fl. oz.	6125
880·780	14880 [31 fl. oz.	13562·5	375	6335·3	5774·3
875	14782·3	13473·5	369·360	6240 [13 fl. oz.	5687·5
852·368	14400 [30 fl. oz.	13125	355·152	6000	5468·8
850	14359·9	13088·5	350	5912·9	5389·4
828·690	14000	12760·5	340·947	5760 [12 fl. oz.	5250
825	13937·6	12703·6	325	5490·6	5004·4
823·956	13920 [29 fl. oz.	12687·5	312·535	5280 [11 fl. oz.	4812·5
800	13515·3	12319	300	5068·2	4619·5
795·544	13440 [28 fl. oz.	12250	295·961	5000	4557·3
75	13092·9	11934	284·123	4800 [10 fl. oz.	4375
769·498	13000	11849	275	4645·9	4234·5
767·131	12960 [27 fl. oz.	11812·5	255·711	4320 [9 fl. oz.	3937·5
750	12670·6	11548·7	250	4223·5	3849·6
738·719	12480 [26 fl. oz.	11375	236·678	4000	3645·9
725	12248·2	11153·7	227·298	3840 [8 fl. oz.	3500
710·307	12000 [25 fl. oz.	10937·5	225	3801·2	3464·6
700	11825·8	10778·8	200	3378·8	3079·7
681·895	11520 [24 fl. oz.	10500	198·886	3360 [7 fl. oz.	3062·5
675	11403·5	10393·8	177·577	3000	2734·4
653·482	11040 [23 fl. oz.	10062·5	175	2956·5	2694·7
651·114	11000	10026	170·474	2880 [6 fl. oz.	2625
650	10981·2	10008·9	150	2534·1	2309·7
625·070	10560 [22 fl. oz.	9625	147·980	2500	2278·7
625	10558·8	9623·9	142	2400 [5 fl. oz.	2187·5
600	10136·4	9238·9	125	2111·8	1924·8
596·658	10080 [21 fl. oz.	9187·5	118·384	2000	1823·9
591·922	10000	9114·6	113·649	1920 [4 fl. oz.	1750
575	9714·1	8854	112·565	1900	1731·8
568·245	9600 [1 pint.	8750	106·646	800	1640·6
550	9291·7	8469	100·728	1700	1549·5
539·833	9120 [19 fl. oz.	8312·5	100	1689·4	1539·8
732·730	9000	8203·2	95	1604·9	1462·8
525	8869·4	8004	94·707	1600	1458·3
511·421	8640 [18 fl. oz.	7875	90	1520·5	1385·8
			88·788	1500	1367·2
			85·237	1440 [3 fl. oz.	1312·5
			85	1435·9	1308·9
			82·869	1400	1276·1
			80	1351·6	1231·86
			76·950	1300	1184·9



Equivalents of Measures of Capacity—*continued*.

Metric Measure.			Imperial Measure.		
Millilitres.	Minims.	Fluid Grains.	Millilitres.	Minims.	Fluid Grains.
75	1267	1154·9	18·942	320	291·7
71	1200	1093·75	18·5	312·5	284·8
70	1182·6	1077·9	18·350	310	282·6
65·111	1100	1002·6	18	304·1	277·1
65	1098·1	1000·9	17·758	300 [5 fl. drm.]	273·4
60	1013·6	923·9	17·5	295·6	269·4
59·192	1000	911·5	17·166	290	264·3
56·825	960 [2 fl. oz.]	875	17	287·2	261·7
55	929·2	846·9	16·574	280	255·2
53·273	900	820·3	16·5	278·8	254
50	844·7	769·9	16·235	274·3	250
47·354	800	729·2	16	270·3	246·3
45	760·2	692·9	15·982	270	246·1
44·394	750	683·6	15·5	261·9	208·6
42·618	620	656·3	15·390	260	236·9
41·434	700	638	15	253·4	230·9
40	675·8	615·9	14·798	250	227·9
35·515	600	546·9	14·5	244·9	223·2
35	591·3	538·9	14·502	245	223·3
30	506·8	461·9	14·206	240 [4 fl. arm.]	218·8
29·596	500	455·7	14	236·5	215·5
28·412	480 [1 fl. oz.]	437·5	13·910	235	214·2
28	473	431·1	13·614	230	209·6
27·821	470	428·4	13·5	228·1	207·8
27·5	464·6	423·5	13·318	225	205·1
27·228	460	419·3	13·022	220	200·5
27	456·1	415·7	13	219·6	200·1
26·637	450	410·2	12·988	219·4	200
26·5	447·7	408·1	12·726	215	195·9
26·045	440	401	12·5	211·2	192·4
26	439·2	400·3	12·430	210	191·4
25·977	438·9	400	12·134	205	186·8
25·5	430·8	392·7	12	202·7	184·7
25·453	430	391·9	11·838	200	182·3
25	422·4	384·9	11·542	195	177·7
24·861	420 [7 fl. drm.]	382·8	11·5	194·3	177·1
24·5	413·9	377·3	11·247	190	173·2
24·269	410	373·7	11	185·8	169·3
24	405·5	369·6	10·951	185	168·6
23·677	400	364·6	10·655	180 [3 fl. drm.]	164·1
23·5	397	361·9	10·5	177·4	161·6
23·085	390	355·5	10·359	175	159·5
23	388·6	354·2	10·063	170	154·9
22·730	383·9	350	10	168·9	153·9
22·5	380·1	346·5	9·741	164·6	150
22·494	380	346·4	9·767	165	150·4
22	371·7	338·8	9·5	160·4	146·3
21·902	370	337·2	9·471	160	145·8
21·5	363·2	331·2	9·175	155	141·3
21·309	360 [6 fl. drm.]	328·1	9	152	138·5
21	354·8	323·4	8·879	150	136·7
20·178	350	319	8·683	145	131·6
20·5	346·3	315·7	8·5	143·6	130·9
20·126	340	309·9	8·287	140	127·6
20	337·9	307·9	8	135·2	123·2
19·534	330	300·8	7·990	135	123
19·5	329·4	300·2	7·695	130	118·7
19·482	329·1	300	7·5	126·7	115·5
19	320·9	292·5	7·399	125	114·1
			7·251	122·5	111·6

# Equivalents of Measures of Capacity—*continued.*

Metric Measure.			Imperial Measure.		
Millilitres.	Minims.	Fluid Grains.	Millilitres.	Minims.	Fluid Grains.
7.103	120 [2 fl. drms.]	109.4	1.184	20	18.2
7	118.3	107.8	1.179	19.8	18
6.807	115	104.8	1.15	19.4	17.7
6.511	110	100.3	1.125	19	17.3
6.5	109.8	100.1	1.1	18.6	17
6.494	109.7	100	1.066	18	16.4
6.215	105	95.7	1.039	17.7	16
6	101.4	92.4	1.006	17	15.5
5.919	100	91.1	1	16.9	15.4
5.845	98.7	90	0.974	16.5	15
5.624	95	86.6	0.95	16.1	14.6
5.5	92.9	84.7	0.947	16	14.5
5.328	90	82	0.918	15.5	14
5.195	87.8	80	0.9	15.2	13.9
5.031	85	77.5			
5	84.5	76.9	0.888	15	13.7
4.736	80	72.9	0.85	14.4	13.1
4.546	76.8	70	0.839	14.2	13
4.5	76	69.3	0.829	14	12.8
4.439	75	68.4	0.8	13.5	12.3
4.143	70	63.8	0.779	13.2	12
4	67.6	61.6	0.770	13	11.9
3.896	65.8	60	0.75	12.7	11.6
3.847	65	59.2	0.710	12	11
			0.7	11.8	10.7
			0.65	11	10.1
			0.649	10.9	10
			0.6	10.1	9.2
3.552	60 [1 fl. drms.]	54.7			
3.5	59.1	53.9	0.592	10	9.1
3.256	55	50.1	0.585	9.9	9
3.247	54.9	50	0.55	9.3	8.5
3	50.7	46.2	0.533	9	8.2
2.959	50	45.6	0.520	8.8	8
2.922	49.4	45	0.5	8.5	7.7
2.664	45	41.1	0.474	8	7.3
2.597	43.8	40	0.45	7.7	7
2.5	42.2	38.5	0.414	7	6.4
2.368	40	36.5	0.4	6.8	6.1
2.273	38.4	35	0.390	6.7	6
2.072	35	31.9	0.355	6	5.5
2	33.8	30.8	0.35	5.9	5.4
1.948	32.9	30	0.325	5.5	5
1.9	32.1	29.3	0.3	5.1	4.7
1.8	30.4	27.7			
1.776	30 [ $\frac{1}{2}$ fl. drms.]	27.3			
1.75	29.6	26.9	0.296	5	4.5
1.7	28.7	26.2	0.260	4.4	4
1.624	27.4	25	0.25	4.2	3.9
1.6	27	24.6	0.237	4	3.7
1.5	25.3	23.1	0.2	3.4	3.1
1.479	25	22.8	0.195	3.3	3
1.421	24	22.8	0.178	3	2.7
1.4	23.7	21.6	0.15	2.5	2.3
1.361	23	20.9	0.130	2.2	2
1.3	22	20.1	0.125	2.1	1.9
1.299	21.9	20	0.118	2	1.8
1.25	21.1	19.2	0.1	1.7	1.5
1.243	21	19	0.065	1.1	1
1.2	20.3	18.5	0.059	1	0.9

Table of Thermometric Equivalents.  
Centigrade (Celsius) and Fahrenheit Scales.

C.°	F.°	C.°	F.°	C.°	F.°	C.°	F.°
—40	—40	—21.1	—6	—3	26.6	15.6	60
—39.4	—39	—21	—5.8	—2.8	27	16	60.8
—39	—38.2	—20.6	—5	—2.2	28	16.1	61
—38.9	—38	—20	—4	—2	28.4	16.7	62
—38.3	—37			—1.7	29	17	62.6
—38	—36.4			—1.1	30	17.2	63
—37.8	—36	—19.4	—3	—1	30.2	17.8	64
—37.2	—35	—19	—2.2	—0.6	31	18	64.4
—37	—34.6	—18.9	—2	0	32	18.3	65
—36.7	—34	—18.3	—1			18.9	66
—36.1	—33	—18	—0.4			19	66.2
—36	—32.8	—17.8	0	0.5	32.9	19.4	67
—35.6	—32	—17.5	0.5	0.6	33	20	68
—35	—31	—17.2	1	1	33.8		
		—17	1.4	1.1	34		
		—16.7	2	1.7	35	20.6	69
—34.4	—30	—16.1	3	2	35.6	21	69.8
—34	—29.2	—16	3.2	2.2	36	21.1	70
—33.9	—29	—15.6	4	2.8	37	21.7	71
—33.3	—28	—15	5	3	37.4	22	71.6
—33	—27.4			3.3	38	22.2	72
—32.8	—27	—14.4	6	3.9	39	22.8	73
—32.2	—26	—14	6.8	4	39.2	23	73.4
—32	—25.6	—13.9	7	4.4	40	23.3	74
—31.7	—25	—13.3	8	5	41	23.9	75
—31.1	—24	—13	8.6			24	75.2
—31	—23.8	—12.8	9			24.4	76
—30.6	—23	—12.2	10	5.6	42	25	77
—30	—22	—12	10.4	6	42.8		
		—11.7	11	6.1	43		
		—11.1	12	6.7	44	25.6	78
—29	—21	—11	12.2	7	44.6	26	78.8
—29	—20.2	—10.6	13	7.2	45	26.1	79
—28.9	—20	—10	14	7.8	46	26.7	80
—28.3	—19			8	46.4	27	80.6
—28	—18.4			8.3	47	27.2	81
—27.8	—18	—9.4	15	8.9	48	27.8	82
—27.2	—17	—9	15.8	9	48.2	28	82.4
—27	—16.6	—8.9	16	9.4	49	28.3	83
—26.7	—16	—8.3	17	10	50	28.9	84
—26.1	—15	—8	17.6			29	84.2
—26	—14.8	—7.8	18			29.4	85
—25.6	—14	—7.2	19	10.6	51	30	86
—25	—13	—7	19.4	11	51.8		
		—6.7	20	11.1	52		
		—6.1	21	11.7	53	30.6	87
—24.4	—12	—6	21.2	12	53.6	31	87.8
—24	—11.2	—5.6	22	12.2	54	31.1	88
—23.9	—11	—5	23	12.8	55	31.7	89
—23.3	—10			13	55.4	32	89.6
—23	—9.4			13.3	56	32.2	90
—22.8	—9	—4.4	24	13.9	57	32.8	91
—22.2	—8	—4	24.8	14	57.2	33	91.4
—22	—7.6	—3.9	25	14.4	58	33.3	92
—21.7	—7	—3.3	26	15	59	33.9	93



Table of Thermometric Equivalents.

C.°	F.°	C.°	F.°	C.°	F.°	C.°	F.°
34	93.2	52.8	127	70.6	159	88	190.4
34.4	94	53	127.4	71	159.8	88.3	191
35	95	53.3	128	71.1	160	88.9	192
		53.9	129	71.7	161	89	192.2
		54	129.2	72	161.6	89.4	193
		54.4	130	72.2	162	90	194
		55	131	72.8	163		
35.6	96			73	163.4		
36	96.8			73.3	164		
36.1	97			73.9	165		
36.7	98			74	165.2		
37	98.6			74.4	166		
37.2	99			75	167		
37.8	100					90.6	195
38	100.4	55.6	132			91	195.8
38.3	101	56	132.8			91.1	196
38.9	102	56.1	133			91.7	197
39	102.2	56.7	134			92	197.6
39.4	103	57	134.6			92.2	198
40	104	57.2	135			92.8	199
		57.8	136			93	199.4
		58	136.4	75.6	168	93.3	200
		58.3	137	76	168.8	93.9	201
		58.9	138	76.1	169	94	201.2
		59	138.2	76.7	170	94.4	202
		59.4	139	77	170.6	95	203
				77.2	171		
40.6	105			77.8	172		
41	105.8			78	172.4		
41.1	106			78.3	173		
41.7	107			78.9	174		
42	107.6			79	174.2		
42.2	108			79.4	175		
42.8	109			80	176		
43	109.4	60	140			95.6	204
43.3	110	60.6	141			96	204.8
43.9	111	61	141.8			96.1	205
44	111.2	61.1	142			96.7	206
44.4	112	61.7	143			97	206.6
45	113	62	143.6			97.2	207
		62.2	144			97.8	208
		62.8	145			98	208.4
		63	145.4	80.6	177	98.3	209
		63.3	146	81	177.8	98.9	210
45.6	114	63.9	147	81.1	178	99	210.2
46	114.8	64	147.2	81.7	179	99.4	211
46.1	115	64.4	148	82	179.6	100	212
46.7	116	65	149	82.2	180		
47	116.6			82.8	181		
47.2	117			83	181.4		
47.8	118			83.3	182		
48	118.4			83.9	183		
48.3	119			84	183.2		
48.9	120			84.4	184		
49	120.2	65.6	150	85	185		
49.4	121	66	150.8			100.6	213
50	122	66.1	151			101	213.8
		66.7	152			101.1	214
		67	152.6			101.7	215
		67.2	153			102	215.6
		67.8	154			102.2	216
		68	154.4	85.6	186	102.8	217
50.6	123	68.3	155	86	186.8	103	217.4
51	123.8	68.9	156	86.1	187	103.3	218
51.1	124	69	156.2	86.7	188	103.9	219
51.7	125	69.4	157	87	188.6	104	219.2
52	125.6	70	158	87.2	189	104.4	220
52.2	126			87.8	190	105	221

Table of Thermometric Equivalents—*continued*.

C.°	F.°	C.°	F.°	C.°	F.°	C.°	F.°
105.6	222	125.6	258	145.6	294	165.6	330
106	222.8	126	258.8	146	294.8	166	330.8
106.1	223	126.1	259	146.1	295	166.1	331
106.7	224	126.7	260	146.7	296	166.7	332
107	224.6	127	260.6	147	296.6	167	332.6
107.2	225	127.2	261	147.2	297	167.2	333
107.8	226	127.8	262	147.8	298	167.8	334
108	226.4	128	262.2	148	298.4	168	334.4
108.3	227	128.3	263	148.3	299	168.3	335
108.9	228	128.9	264	148.9	300	168.9	336
109	228.2	129	264.2	149	300.2	169	336.2
109.4	229	129.4	265	149.4	301	169.4	337
110	230	130	266	150	302	170	338
110.6	231	130.6	267	150.6	303	170.6	339
111	231.8	131	267.8	151	303.8	171	339.8
111.1	232	131.1	268	151.1	304	171.1	340
111.7	233	131.7	269	151.7	305	171.7	341
112	233.6	132	269.6	152	305.6	172	341.6
112.2	234	132.2	270	152.2	306	172.2	342
112.8	235	132.8	271	152.8	307	172.8	343
113	235.4	133	271.4	153	307.4	173	343.4
113.3	236	133.3	272	153.3	308	173.3	344
113.9	237	133.9	273	153.9	309	173.9	345
114	237.2	134	273.2	154	309.2	174	345.2
114.4	238	134.4	274	154.4	310	174.4	346
115	239	135	275	155	311	175	347
115.6	240	135.6	276	155.6	312	175.6	348
116	240.8	136	276.8	156	312.8	176	348.8
116.1	241	136.1	277	156.1	313	176.1	349
116.7	242	136.7	278	156.7	314	176.7	350
117	242.6	137	278.6	157	314.6	177	350.6
117.2	243	137.2	279	157.2	315	177.2	351
117.8	244	137.8	280	157.8	316	177.8	352
118	244.4	138	280.4	158	316.4	178	352.4
118.3	245	138.3	281	158.3	317	178.3	353
118.9	246	138.9	282	158.9	318	178.9	354
119	246.2	139	282.2	159	318.2	179	354.2
119.4	247	139.4	283	159.4	319	179.4	355
120	248	140	284	160	320	180	356
120.6	249	140.6	285	160.6	321	180.6	357
121	249.8	141	285.8	161	321.8	181	357.8
121.1	250	141.1	286	161.1	322	181.1	358
121.7	251	141.7	287	161.7	323	181.7	359
122	251.6	142	287.6	162	323.6	182	359.6
122.2	252	142.2	288	162.2	324	182.2	360
122.8	253	142.8	289	162.8	325	182.8	361
123	253.4	143	289.4	163	325.4	183	361.4
123.3	254	143.3	290	163.3	326	183.3	362
123.9	255	143.9	291	163.9	327	183.9	363
124	255.2	144	291.2	164	327.2	184	363.2
124.4	256	144.4	292	164.4	328	184.4	364
125	257	145	293	165	329	185	365

Table of Thermometric Equivalents—*continued.*

C.°	F.°	C.°	F.°	C.°	F.°	C.°	F.°
185.6	366	205.6	402	225.6	438	245.6	474
186	366.8	206	402.8	226	438.8	246	474.8
186.1	367	206.1	403	226.1	439	246.1	475
186.7	368	206.7	404	226.7	440	246.7	476
187	368.6	207	404.6	227	440.6	247	476.6
187.2	369	207.2	405	227.2	441	247.2	477
187.8	370	207.8	406	227.8	442	247.8	478
188	370.4	208	406.4	228	442.4	248	478.4
188.3	371	208.3	407	228.3	443	248.3	479
188.9	372	208.9	408	228.9	444	248.9	480
189	372.2	209	408.2	229	444.2	249	480.2
189.4	373	209.4	409	229.4	445	249.4	481
190	374	210	410	230	446	250	482
190.6	375	210.6	411	230.6	447	250.6	483
191	375.8	211	411.8	231	447.8	251	483.8
191.1	376	211.1	412	231.1	448	251.1	484
191.7	377	211.7	413	231.7	449	251.7	485
192	377.6	212	413.6	232	449.6	252	485.6
192.2	378	212.2	414	232.2	450	252.2	486
192.8	379	212.8	415	232.8	451	252.8	487
193	379.4	213	415.4	233	451.4	253	487.4
193.3	380	213.3	416	233.3	452	253.3	488
193.9	381	213.9	417	233.9	453	253.9	489
194	381.2	214	417.2	234	453.2	254	489.2
194.4	382	214.4	418	234.4	454	254.4	490
195	383	215	419	235	455	255	491
195.6	384	215.6	420	235.6	456	255.6	492
196	384.8	216	420.8	236	456.8	256	492.8
196.1	385	216.1	421	236.1	457	256.1	493
196.7	386	216.7	422	236.7	458	256.7	494
197	386.6	217	422.6	237	458.6	257	494.6
197.2	387	217.2	423	237.2	459	257.2	495
197.8	388	217.8	424	237.8	460	257.8	496
198	388.4	218	424.4	238	460.4	258	496.4
198.3	389	218.3	425	238.3	461	258.3	497
198.9	390	218.9	426	238.9	462	258.9	498
199	390.2	219	426.2	239	462.2	259	498.2
199.4	391	219.4	427	239.4	463	259.4	499
200	392	220	428	240	464	260	500
200.6	393	220.6	429	240.6	465	260.6	501
201	393.8	221	429.8	241	465.8	261	501.8
201.1	394	221.1	430	241.1	466	261.1	502
201.7	395	221.7	431	241.7	467	261.7	503
202	395.6	222	431.6	242	467.6	262	503.6
202.2	396	222.2	432	242.2	468	262.2	504
202.8	397	222.8	433	242.8	469	262.8	505
203	397.4	223	433.4	243	469.4	263	505.4
203.3	398	223.3	434	243.3	470	263.3	506
203.9	399	223.9	435	243.9	471	263.9	507
204	399.2	224	435.2	244	471.2	264	507.2
204.4	400	224.4	436	244.4	472	264.4	508
205	401	225	437	245	473	265	509





# Pharmacopedic Atlas

*AN ILLUSTRATED*

SUPPLEMENT TO 'PHARMACOPEDIA'



## List of Plates.

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- I. ACONITI FOLIA; ACONITI RADIX; AGROPYRI (TRITICI) RHIZOMA; AMYLUM.
- II. AMYGDALÆ; ANETHI FRUCTUS; ANISI FRUCTUS; ANISI STELLATI FRUCTUS.
- III. ANTHEMIDIS FLORES; ARNICÆ RHIZOMA; ARNICÆ FLORES; ARMORACIÆ RADIX.
- IV. BELLADONNÆ FOLIA; BELLADONNÆ RADIX.
- V. BRYONIÆ RADIX; BUCHU FOLIA; CALUMBÆ RADIX; COSCINIUM.
- VI. CANNABIS INDICA; CANTHARIS; MYLABRIS.
- VII. CALENDULÆ FLORES; CANELLÆ CORTEX; CAPSICI FRUCTUS; CARDAMOMI SEMINA; CARUI FRUCTUS; CARYOPHYLLUM.
- VIII. CASCARA SAGRADA; CASCARILLA; CIMICIFUGÆ RHIZOMA.
- IX. CINCHONÆ RUBRÆ CORTEX; CINCHONÆ LANCIFOLIÆ CORTEX.
- X. CINCHONÆ FLAVÆ CORTEX; CINNAMOMI CORTEX; CASSIÆ CORTEX.
- XI. CHIRATA; CISSAMPELOS.
- XII. COCÆ FOLIA; COLCHICI CORMUS; COLCHICI SEMINA.
- XIII. COCCUS; COLOCYNTHIDIS PULPA; CUMINI FRUCTUS; CROCUS.
- XIV. CONII FOLIA; CUSO; CORIANDRI FRUCTUS.
- XV. CONII FRUCTUS; CUBEBÆ FRUCTUS.
- XVI. CUSPARIÆ CORTEX; DIGITALIS FOLIA; DULCAMARA.
- XVII. ERGOTA; EUONYMI CORTEX; FILIX MAS; FÆNICULI FRUCTUS.
- XVIII. GALLA; GELSEMI RADIX; GENTIANÆ RADIX.
- XIX. GLYCYRRHIZÆ RADIX.
- XX. GRANATI CORTEX; HIRUDO.
- XXI. GRINDELIA; HAMAMELIDIS FOLIA.
- XXII. HAMAMELIDIS CORTEX; HEMIDESMI RADIX.

LIST OF PLATES.—*Continued.*

- XXIII. HYOSCYAMI FOLIA; HYOSCYAMI SEMINA.  
 XXIV. HYDRASTIS RHIZOMA; IPECACUANHÆ RADIX.  
 XXV. IPECACUANHÆ RADIX.  
 XXVI. JABORANDI FOLIA; JALAPA.  
 XXVII. KRAMERIÆ RADIX; LARICIS CORTEX.  
 XXVIII. MEZEREI CORTEX.  
 XXIX. LUPULUS; LUPULINUM; MYRISTICA; NUX VOMICA.  
 XXX. OPIUM.  
 XXXI. PAPAVERIS CAPSULÆ; PAREIRÆ RADIX.  
 XXXII. PAREIRÆ RADIX.  
 XXXIII. PHYSOSTIGMATIS SEMINA; PIMENTA; PIPER NIGRUM; PODO-  
 PHYLLI RHIZOMA.  
 XXXIV. PRUNI VIRGINIANÆ CORTEX; PYRETHRI RADIX.  
 XXXV. QUERCUS CORTEX; QUILLAIÆ CORTEX.  
 XXXVI. RHEI RADIX.  
 XXXVII. SASSAFRAS RADIX.  
 XXXVIII. SARSÆ RADIX; SCAMMONIÆ RADIX.  
 XXXIX. SABINÆ CACUMINA; SCOPARII CACUMINA; SENEGÆ RADIX.  
 XL. SENNA ALEXANDRINA; SENNA INDICA.  
 XLI. SERPENTARIÆ RHIZOMA; SINAPIS NIGRÆ SEMINA.  
 XLII. STRAMONII FOLIA; STRAMONII SEMINA.  
 XLIII. STAPHISAGRIÆ SEMINA; STROPHANTHI SEMINA; SUMBUL RADIX;  
 UVÆ URSI FOLIA.  
 XLIV. TARAXACI RADIX; VALERIANÆ RHIZOMA.  
 XLV. ULMI CORTEX; ULMI FULVÆ CORTEX.  
 XLVI. ZINGIBER.

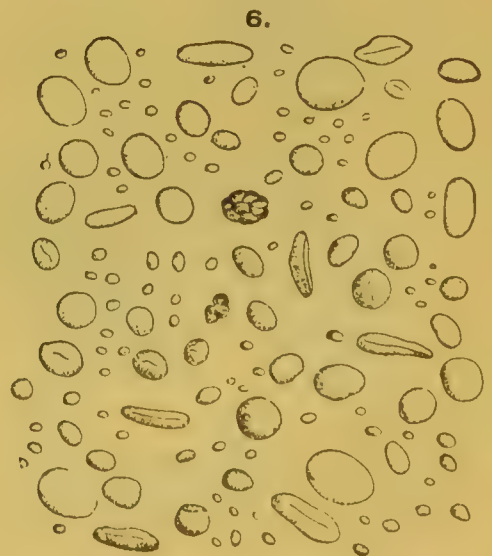
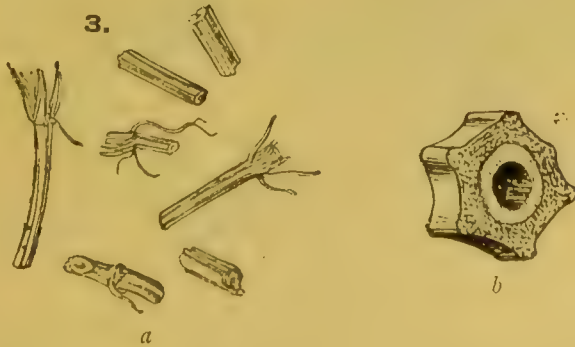
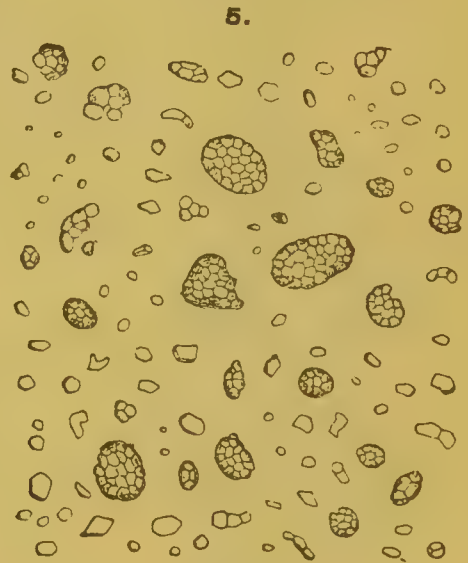
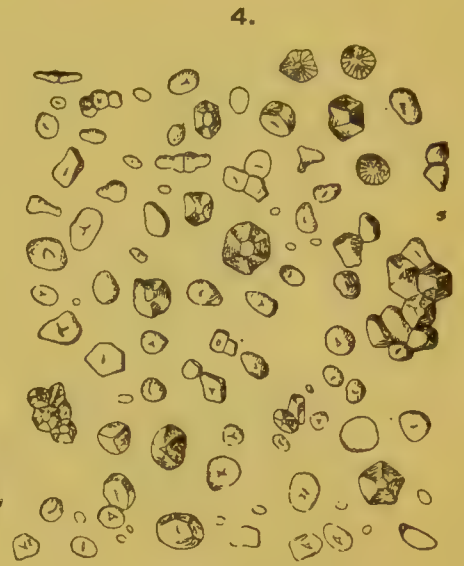
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\*.\* Such illustrations in the following plates as are not entirely original have been re-drawn or copied from illustrations by Holmes, Fitch, and others in the *Pharmaceutical Journal*, or from the atlases or other works of Vogl, Tschirch and Oesterle, Brandt and Ratzeburg, Berg, or Luerssen.



## PLATE I.

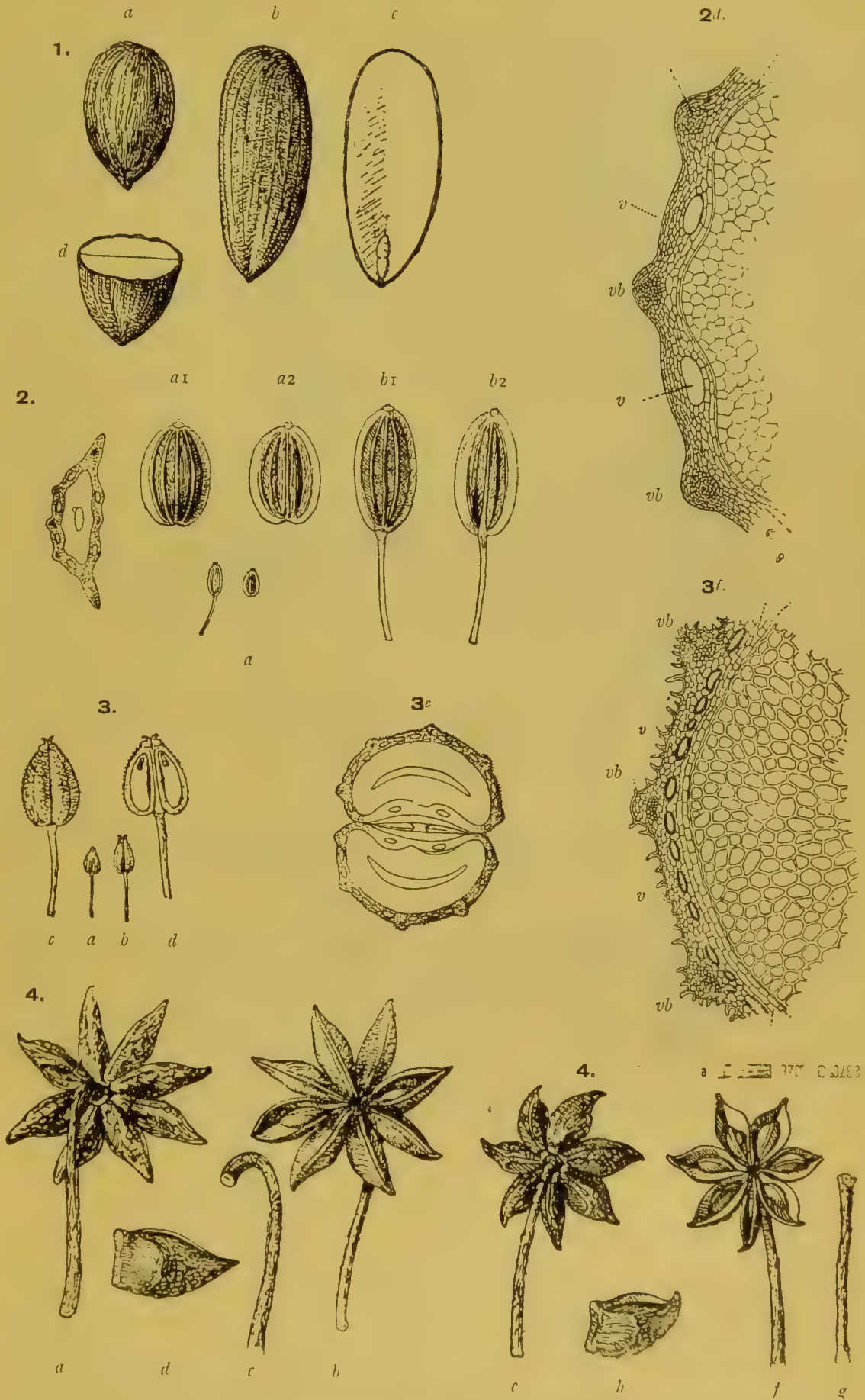
1. **Aconiti Folia.**—*a*, Leaf of *Aconitum Napellus*, Linné, roundish in general outline and divided down to the leafstalk into three segments, the two lateral segments being again divided nearly to the leafstalk, while each of the five principal divisions is subdivided twice or thrice into nearly opposite, linear, tapering, acute segments, the lowest of which are longer than the rest and somewhat spreading; *b*, flower, with blue, helmet-shaped, shallow, and semi-circular upper sepal; *c.d*, stamens. All three-fourths natural size.
2. **Aconiti Radix.**—*a*, Old root of *Aconitum Napellus*, Linné, with remains of stem; *b*, new root, with leaf bud; *c*, transverse section of root, enlarged, showing stellate cambium.
3. **Agropyri (Tritici) Rhizoma.**—*a*, Rhizome of *Agropyrum repens*, Beauvois, as seen in commerce, with longitudinal furrows and hollow stele; *b*, transverse section of rhizome, enlarged.
4. **Amylum Maïdis.**—Starch of *Zea Mays*, Linné ( $\times 200$ ), consisting of round or rounded polygonal granules, from  $10\mu$  to  $25\mu$  in diameter. After Tschirch and Oesterle.
5. **Amylum Oryzæ.**—Starch of *Oryza sativa*, Linné ( $\times 200$ ), consisting of polygonal granules with sharp angles, from  $4\mu$  to  $6\mu$  in diameter. After Tschirch and Oesterle.
6. **Amylum Tritici.**—Starch of *Triticum sativum*, Lamarck ( $\times 200$ ), consisting of rounded granules, from  $6\mu$  to  $38\mu$  in diameter. After Tschirch and Oesterle.



## PLATE II.

1. **Amygdalæ.**—*a*, Seed of *Prunus Amygdalus*, Stokes, var. *amara*, Baillon, short and broadly ovoid; *b*, seed of *P. Amygdalus*, var. *dulcis*, Baillon, elongated oblong; *c*, same, split longitudinally, to show cotyledon and radicle; *d*, seed cut transversely to show cotyledons.
2. **Anethi Fructus.**—*a*, Fruit (British) of *Peucedanum graveolens*, Bentham and Hooker filius, detached from pedicel and consisting of flat and usually separated mericarps, with three dorsal ridges and two winged lateral ridges; *a1*, convex side of mericarp (*a*), enlarged; *a2*, flat side of same, enlarged; *b*, Indian dill fruit with mericarps united and attached to pedicel; *b1*, convex side of mericarp (*b*), enlarged; *b2*, flat side of same, enlarged; *c*, transverse section of mericarp, enlarged; *d*, same, much enlarged, showing vittæ (*v*) and vascular bundles (*vb*), after Berg.
3. **Anisi Fructus.**—*a*, Fruit (Russian) of *Pimpinella Anisum*, Linné, with usually entire cremocarp and prominent crenations on the primary ridges; *b*, Maltese anise fruit; *c*, same, enlarged; *d*, longitudinal section of same, enlarged; *e*, transverse section of fruit, enlarged, after Tschirch and Oesterle; *f*, same, much enlarged, showing vittæ (*v*) and vascular bundles (*vb*), after Tschirch and Oesterle.
4. **Anisi Stellati Fructus.**—*a*, Fruit of *Illicium verum*, Hooker filius, about 3 to 4 Cm. in diameter, with curved stalk, dark brown seeds, and anise odour; *b*, same, showing slightly open carpels, with seeds only partly exposed; *c*, detached stalk; *d*, carpel, with straight tip; *e*, fruit of poisonous, false star anise, *Illicium religiosum*, Siebold, with straight stalk, yellowish-brown seeds, and no anise odour; *f*, same, showing widely open carpels, with seeds much exposed; *g*, detached stalk; *h*, carpel, with incurved tip.

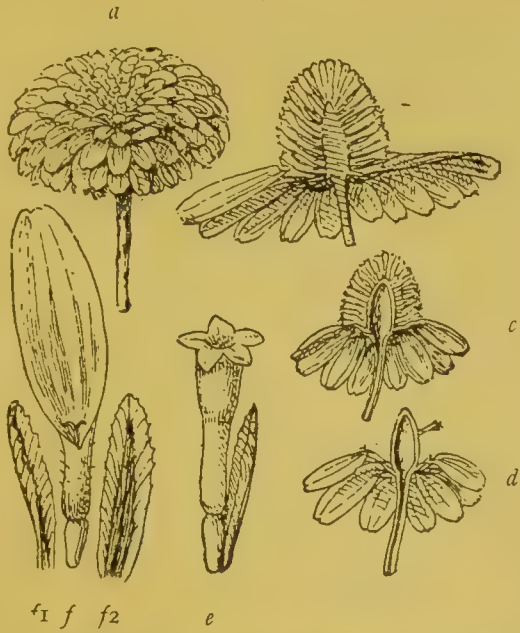




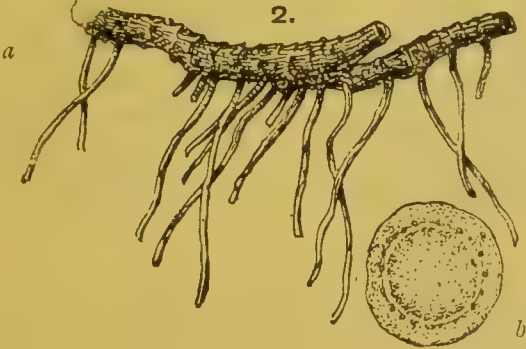
## PLATE III.

1. **Anthemidis Flores.**—*a*, Double flower-head of *Anthemis nobilis*, Linné; *b*, single flower-head, cut vertically through thalamus, showing solid, elongated, conical receptacle and blunt, narrow, scaly bracts or paleæ; *c, d*, flower-heads of *Matricaria chamomilla*, Linné, cut vertically through thalamus, showing hollow receptacle and no paleæ; *e*, central floret of true chamomile with palea, enlarged; *f*, ray floret of same, with phyllaries, *f* 1 and *f* 2, enlarged.
2. **Arnicae Rhizoma.**—*a*, Rhizome and rootlets of *Arnica montana*, Linné; *b*, transverse section of rhizome, showing thick bark, enclosing a ring of oleo-resin ducts near the wood.
3. **Arnicae Flores.**—*a*, Flower-head of *Arnica montana*, Linné; *b*, ray floret of same, enlarged, showing narrow, ligulate corolla, terminating in three teeth.
4. **Armoraciae Radix.**—*a*, Root of *Cochlearia Armoracia*, Linné, showing elongated cylindrical shape; *b*, transverse section of same.

1.



2.



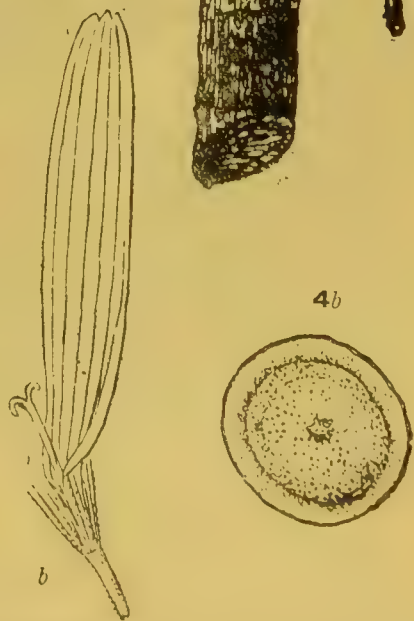
3.



4a.



4b.

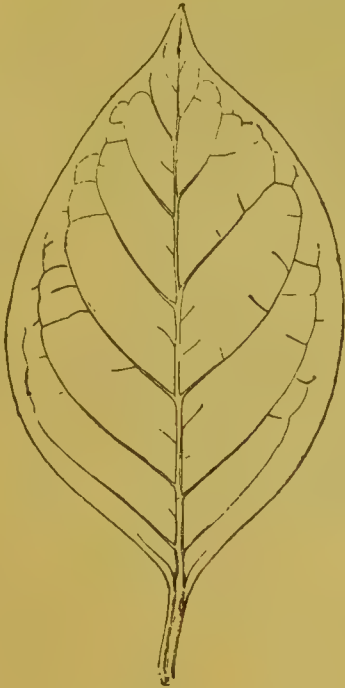




## PLATE IV.

1. **Belladonnæ Folia.**—*a*, Upper leaf of *Atropa belladonna*, Linné, one-half natural size, showing outline and venation; *b*, transverse section of same, enlarged (after Vogl), showing (*e*, *é*) epidermis, (*p*) palisade cells, (*k*) cells filled with sandy crystals, (*h*) hairs, (*d*) glandular hairs and stalked septate glands; *c*, lower epidermis of leaf, enlarged (after Vogl), showing (*k*) crystal cells, (*st*) stomata, (*fv*) fibro-vascular bundle.
2. **Belladonnæ Radix.**—*a*, Young root of *Atropa belladonna*, Linné; *b*, transverse section of same, enlarged, showing non-fibrous bark, separated by the cambium layer from the wood, to which it adheres closely; *c*, transverse section, enlarged, of upper part of older root, where it passes into rhizome, exhibiting an evident pith and ring of radiate wood; *d*, transverse section of woody portion of root, much enlarged (after Vogl), showing (*k*) cells containing sandy crystals, (*pr*) parenchyma filled with starch, (*fv*) fibro-vascular bundle, (*ms*) medullary rays.

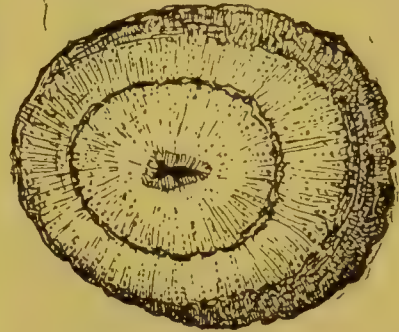
1a.



2a.



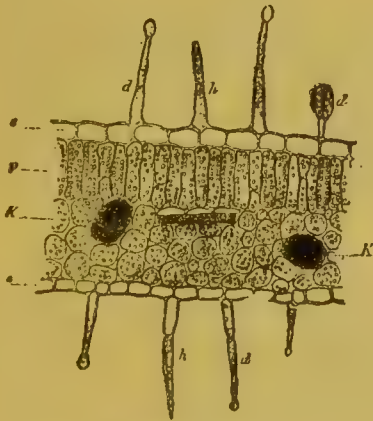
2c.



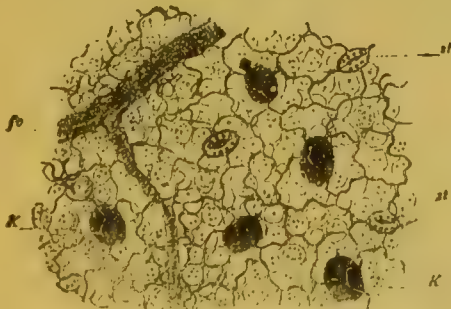
2b.



1b.



2b.



1c.

## PLATE V.

1. **Bryoniæ Radix.**—Transverse section of root of *Bryonia dioica*, Jacquin, with thin, longitudinally wrinkled bark, enclosing a large fleshy wood in which occur numerous small projecting groups of vessels arranged in circles and radiating lines. Compare with *Calumbæ Radix*.
2. **Buchu Folia.**—A, Leaves, natural size: *a*, *Barosma betulina*, Bartling and Wendland; *b*, *B. crenulata*, Hooker; *c*, *B. serratifolia*, Willdenow; *d*, *Empleurum serrulatum*, Aiton. B, Tips of leaves, enlarged: *a1*, *B. betulina*; *b1*, *B. crenulata*; *c1*, *B. serratifolia*; *d1*, *E. serrulatum*. C, Lower epidermis of buchu leaf (after Planchon and Collin), showing crystals of hesperidin and sphæraphides. D, Transverse section of buchu leaf (after Planchon and Collin), showing sub-epidermal mucilage cells and oil glands.
3. **Calumbæ Radix.**—*a*, Transverse section of root of *Jateorhiza Columba*, Miers, showing a wrinkled corky layer, a thick bark marked with radiating lines of sieve tissue, and a central woody portion separated from the bark by a dark cambium line; *b.b*, starch grains found in wood and bark, enlarged. After Berg and Schmidt.
4. **Coscinium.**—Transverse section of stem of *Coscinium jensestratum*, Colebrooke, showing the numerous semi-lunar masses of phloem in the cortex, the wood consisting of a single ring of wedge-shaped bundles containing many large vessels, and the small central pith. The stem contains no starch. Compare with *Calumbæ Radix*.



1.



2A.



a



b



c



d

2B.



aI



bI



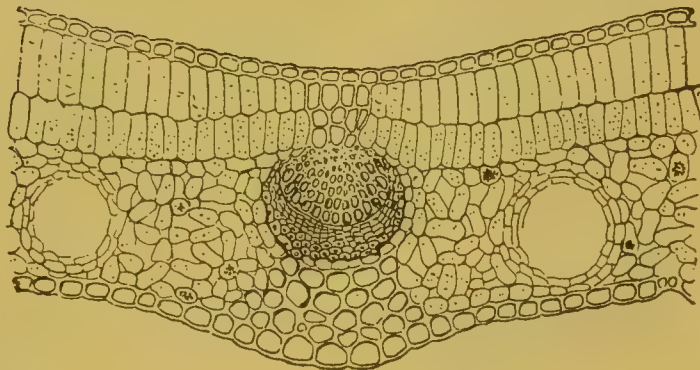
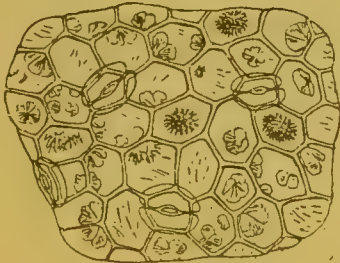
cI



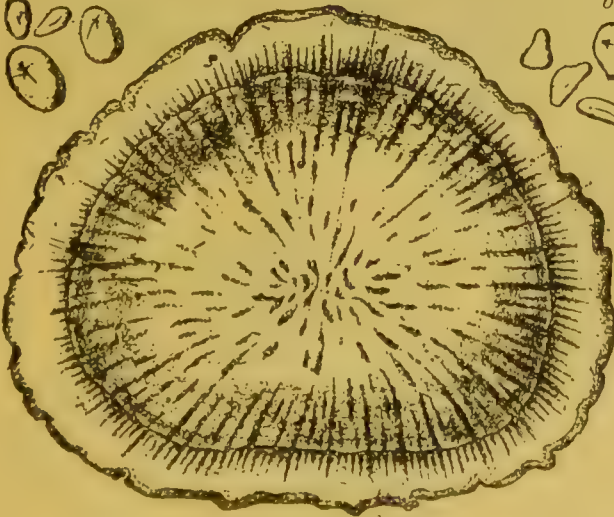
dI

2D.

2C.



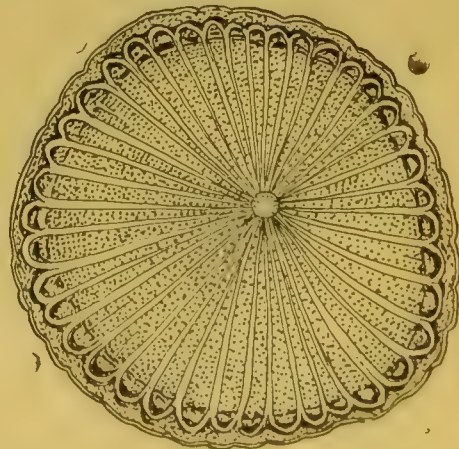
3.



a

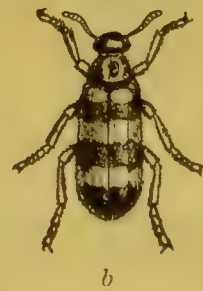
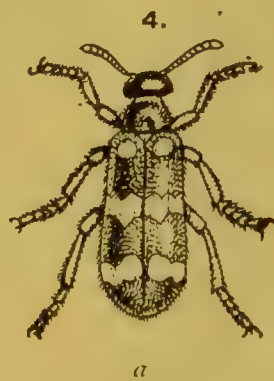
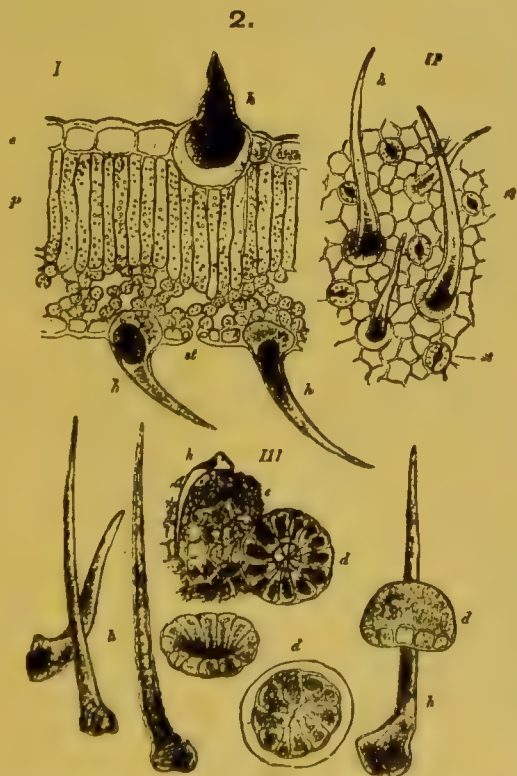
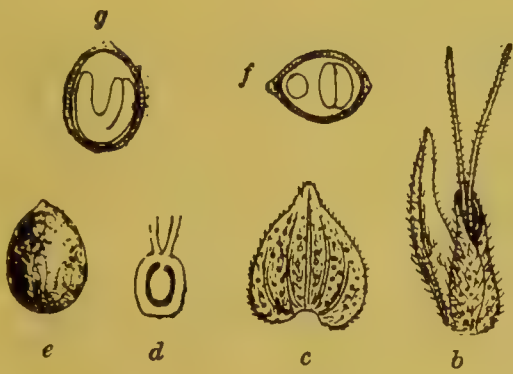
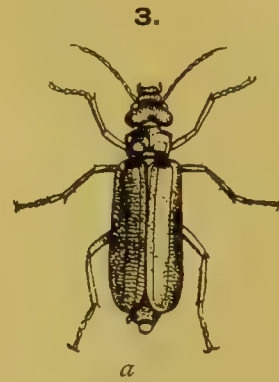


4.



## PLATE VI.

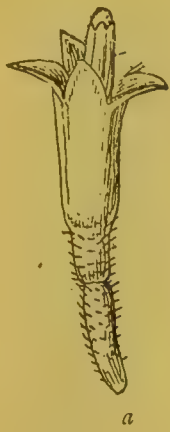
1. **Cannabis Indica.**—*a*, Young leaf of *Cannabis sativa*, Linné; *b*, female flower of same, with linear bract; *c*, perianth unrolled; *d*, longitudinal section of ovary; *e*, fruit; *f*, transverse section of fruit; *g*, longitudinal section of same; *b* to *g*, enlarged.
2. **Cannabis Indica.**—I., Transverse section of leaf, enlarged, showing (*e*) epidermis, (*p*) palisade cells, (*st*) stoma, (*h*) hairs; II., lower epidermis, enlarged, showing hairs (*h*) and stomata (*st*); III., elements of powder, showing detached hairs (*h*) and glands (*d*), enlarged. After Vogl.
3. **Cantharis.**—*a*, Dried beetle, *Cantharis vesicatoria*, Latreille; *b*, same, with elytra and wing-sheaths expanded.
4. **Mylabris.**—*a*, Chinese blistering beetle, *Mylabris phalerata*, showing spots and two broad, wavy, transverse bands on elytra; *b*, *M. cichorii*.





## PLATE VII.

1. **Calendulæ Flores.**—*a*, Disc floret of *Calendula officinalis*, Linné; *b*, ray floret of same, showing the short, hairy tube enclosing the remains of a filiform style which terminates in two elongated branches, and the ligulate corolla, terminating in three teeth and exhibiting four principal veins; *a* and *b*, enlarged. Compare with *Arnicae Flores* and *Crocus*.
2. **Canellæ Cortex.**—*a*, Bark of *Canella alba*, Murray, showing scars or spots on outer surface; *b*, transverse section of same, enlarged, showing oil-cells and medullary rays.
3. **Capsici Fructus.**—*a*, Fruit of *Capsicum minimum*, Roxburgh; *b*, same, with peduncle attached; *c*, detached peduncle.
4. **Cardamomi Semina.**—*a*, Different commercial varieties of fruit of *Elettaria Cardamomum*, Maton; *b*, transverse section of fruit; *c*, cardamom seeds, showing transverse wrinkles and abruptly tapering apex; *d*, grains of Paradise, the seeds of *Amomum Melegueta*, Roscoe, showing papillose surface and large projecting funiculus.
5. **Carui Fructus.**—*a*, Fruit of Mogador caraway fruit, *Carum Carvi*, Linné; *b*, English fruit; *c*, Russian fruit; *a1*, *b1*, *c1*, the same enlarged. The mericarps, which are usually separated, contain six vittæ and are traversed from base to apex by five narrow primary ridges, each of which contains a fibro-vascular bundle.
6. **Caryophyllum.**—*a*, Fruit of *Eugenia caryophyllata*, Thunberg; *b*, longitudinal section of same, enlarged, showing oil-glands in the calyx-tube, calyx-teeth, and overlapping petals.



a



3.



a

5.

a o c



a1



b1



c1



b

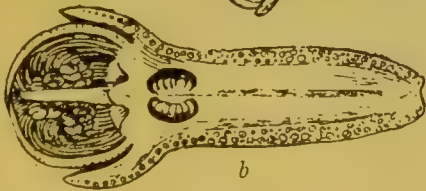


c

6.



a



b

4d



b



4.

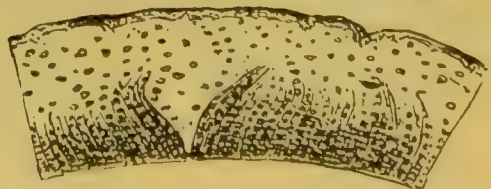


c



d

2b.



2a.



## PLATE VIII.

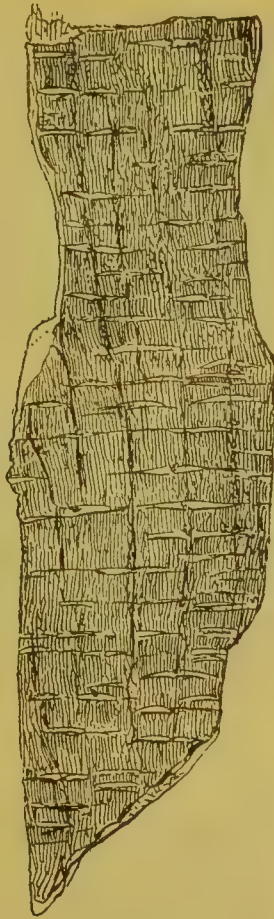
1. *Cascara Sagrada*.—*a*, Outer surface of bark of *Rhamnus purshianus*, De Candolle, showing lenticels and patches of lichen; *b*, flat piece of older bark; *c*, inner surface of bark, showing faint transverse corrugations and longitudinal striations; *d*, outer surface of bark of *Rhamnus frangula*, Linné, showing lenticels.
2. *Cascarilla*.—*a*, Bark of *Croton Eluteria*, J. J. Bennett, showing chalky appearance, longitudinal wrinkles, and longitudinal and transverse cracks; *b*, transverse section of same, enlarged, showing numerous thin medullary rays traversing the bark.
3. *Cimicifugæ Rhizoma*.—*a*, Branched rhizome and roots of *Cimicifuga racemosa*, Nuttall; *b*, transverse section of rhizome, enlarged; *c*, transverse section of root, enlarged.



1a.



1b.



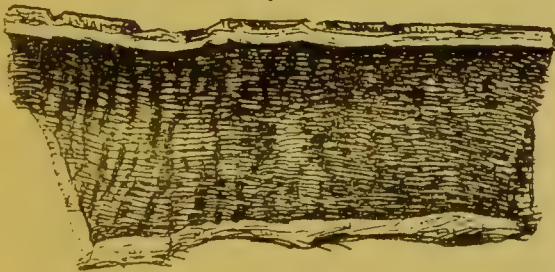
1d.



2a.



1c.



2b.



3.



a



c



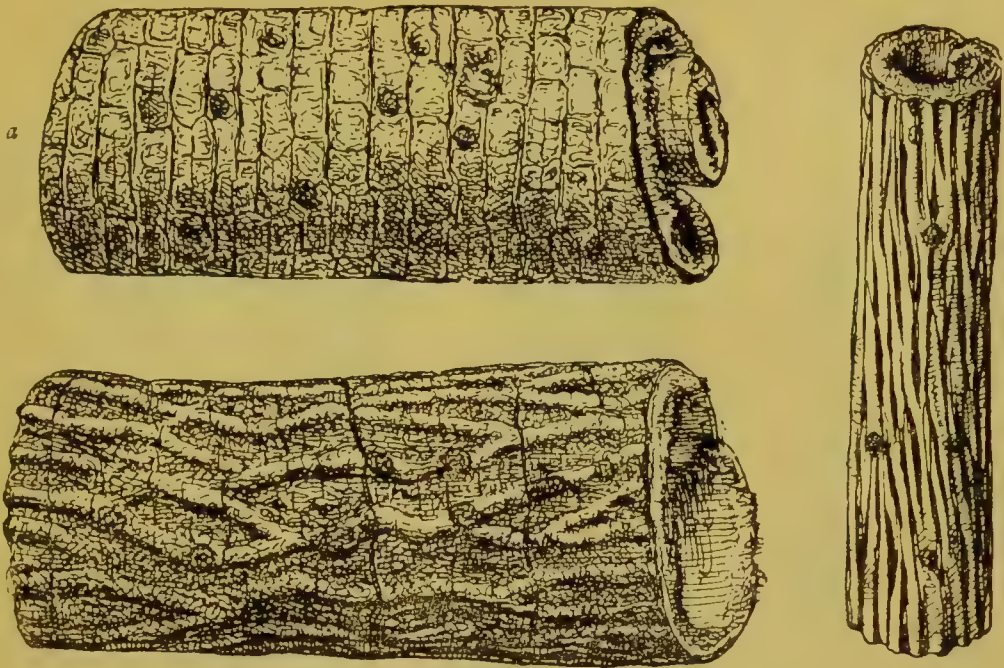
b

## PLATE IX.

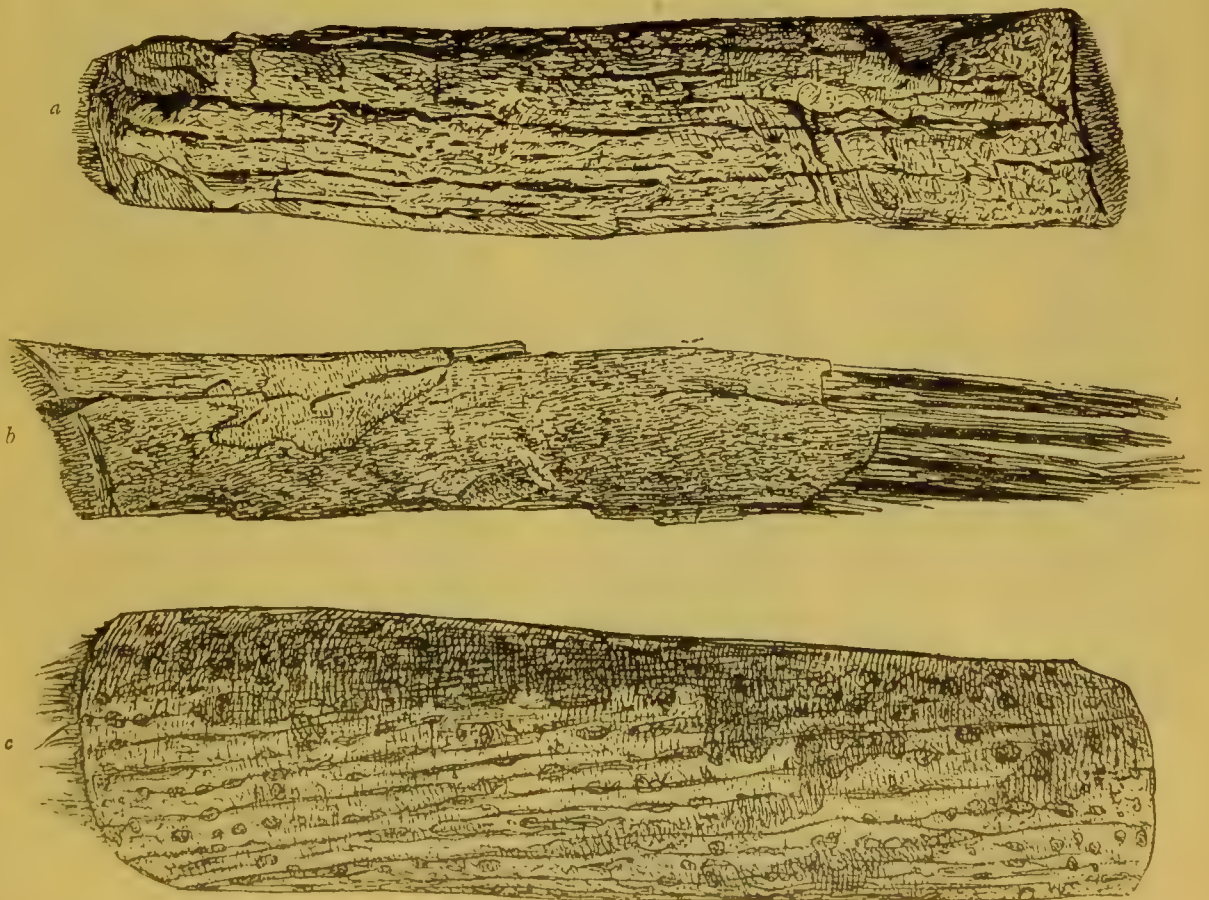
1. **Cinchonæ Rubræ Cortex.**—*a*, Stem bark of East Indian *Cinchona succirubra*, Pavon; *b*, branch bark of same, showing warts and longitudinal wrinkles; *c*, stem bark of Jamaica *C. succirubra*.
2. **Cinchonæ Lancifoliæ Cortex.**—*a*, Older quill of soft Colombian bark, from *Cinchona lancifolia*, Mutis, showing patches of cork; *b*, young quill of same; *c*, hard Cartagena bark.



1.



2.

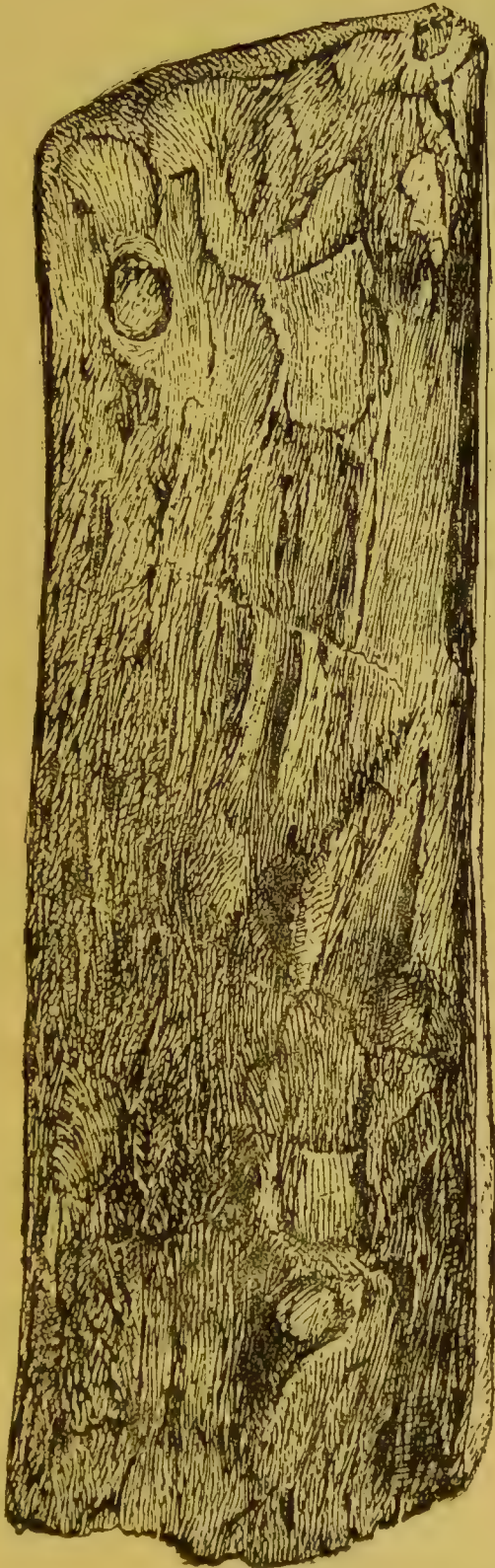




## PLATE X.

1. **Cinchonæ Flavæ Cortex.**—*a*, Outer surface of flat bark of *Cinchona Calisaya*, Weddell; *b*, quill bark of same, showing longitudinal furrows, transverse cracks, and exfoliating cork.
2. **Cinnamomi Cortex.**—Bark of *Cinnamomum zeylanicum*, Breyne, showing compound quill, without cork, and marked with narrow, wavy, longitudinal lines.
3. **Cassiæ Cortex.**—Bark of *C. Cassia*, Blume, showing thick single quill, bearing patches of cork.

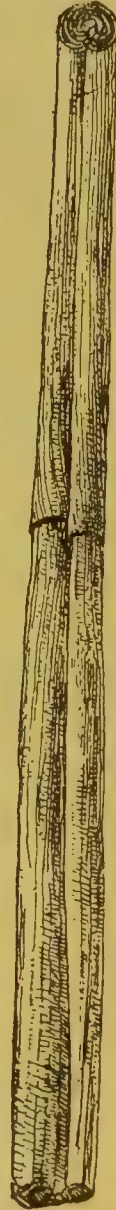
1a.



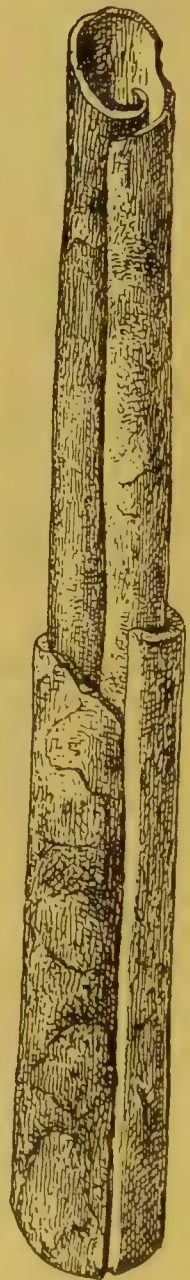
1b.



2.



3.



## PLATE XI.

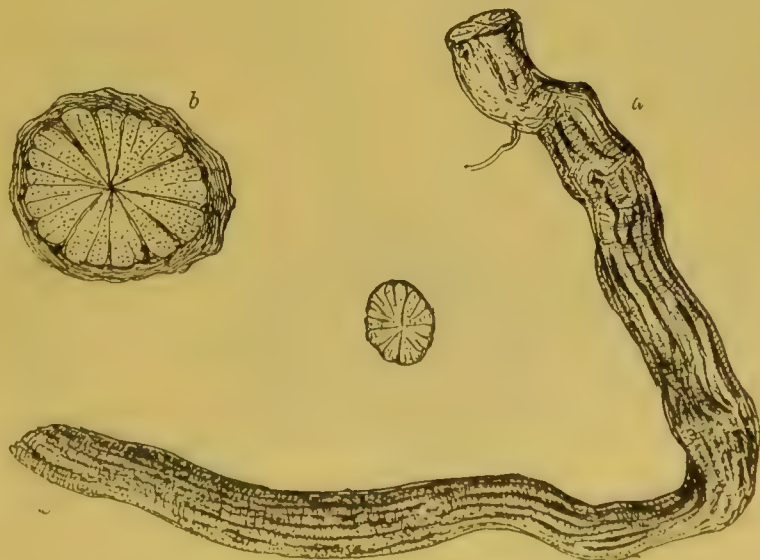
1. **Chirata.**—*a*, Inflorescence of *Swertia Chirata*, Hamilton, with rounded stem and opposite leaves; *b*, longitudinal section of stem; *c*, detached flower, enlarged, showing calyx; *d*, corolla, laid open to show nectariferous glands, enlarged; *e*, ovary, enlarged; *f*, transverse section of ovary, enlarged.
2. **Cissampelos.**—*a*, Root of East Indian *Cissampelos Pareira*, Linné, with transverse section of same, showing narrow bark surrounding a woody column consisting of a single ring of radial woody wedges, separated from each other by distinct narrow medullary rays; *b*, transverse section of larger root, from Jamaica. Compare with *Pareiræ Radix*.



1.



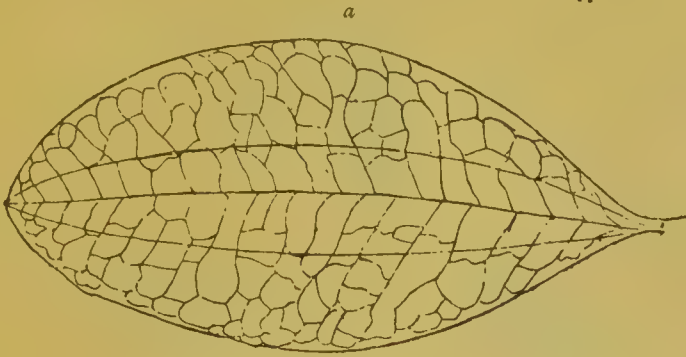
2.



## PLATE XII.

1. **Cocæ Folia.**—*a*, Bolivian (Huanuco) coca leaf, from *Erythroxylon Coca*, Lamarck, var. *bolivianum*, Burck; *b*, transverse section of under epidermis of coca leaf, enlarged, showing papillæ, after Moeller; *c*, Peruvian (Truxillo) leaf, from *E. truxillense*, Rusby, or *E. Coca*, var. *novo-granatense*, Morris; *d*, Java coca leaf, from *E. Coca*, var. *spruceanum*, Burck.
2. **Colchici Cormus.**—*a*, Corm of *Colchicum autumnale*, Linné; *b*, transverse slices of same.
3. **Colchici Semina.**—*a*, Seeds of *Colchicum autumnale*, Linné, showing remains of funiculus; *b*, seed, enlarged; *c*, transverse section of seed, enlarged, showing embryo.

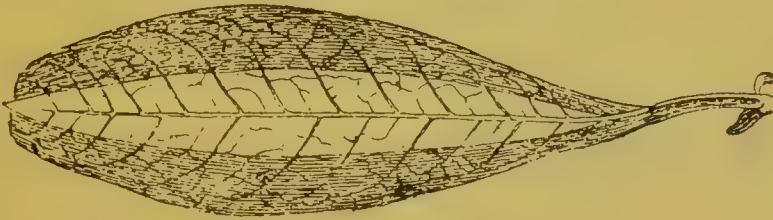
1.



b.



c



d.



2a



3.

c

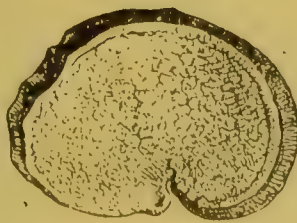


b



a

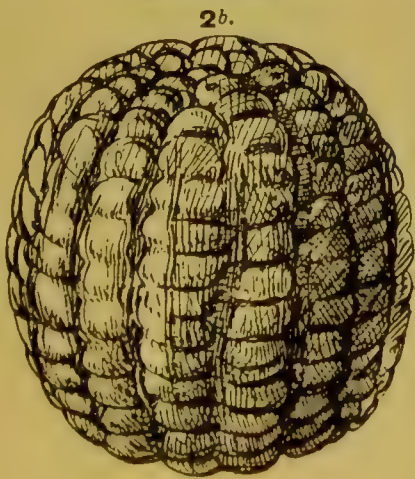
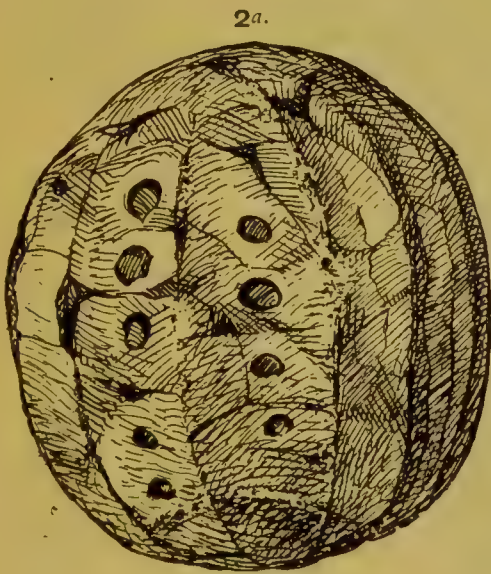
2b.





## PLATE XIII.

1. **Coccus.**—*a*, Adult female of *Coccus Cacti*, Linné; *b*, same, enlarged; *c*, impregnated female, natural size; *d*, male insect, larval form; *e*, same, winged form.
2. **Colocynthis Pulpa.**—*a*, Peeled fruit of Spanish colocynth, from *Citrullus Colocynthis*, Schrader, as imported; *b*, Persian colocynth fruit.
3. **Cumini Fructus.**—*a*, Maltese cummin fruit, from *Cuminum Cyminum*, Linné; *b*, Mogador fruit; *c*, single mericarp of Maltese fruit, enlarged, showing ridges; *d*, commissural surface of same, enlarged; *e*, transverse section of same, enlarged, showing vittæ.
4. **Crocus.**—*a*, Complete plant of *Crocus sativus*, Linné, one-fourth natural size, showing protruding stigma; *b*, same, with perianth, leaves, and scales removed, showing section through corm and ovary; *c*, upper part of stigma, enlarged.

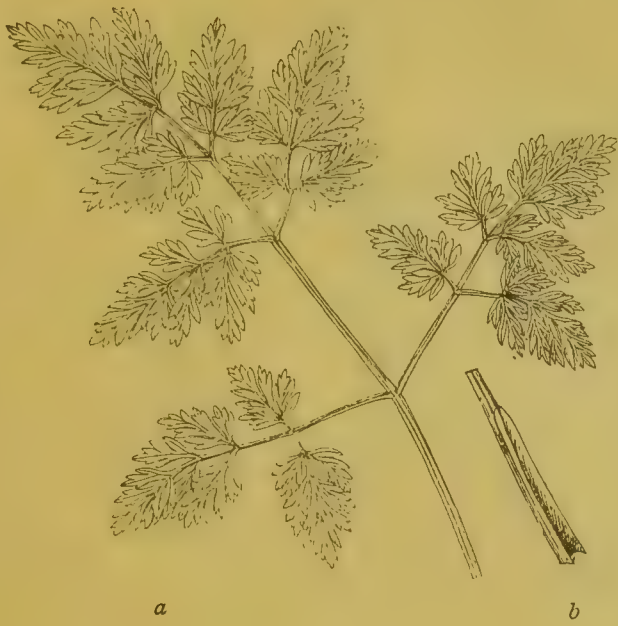


## PLATE XIV.

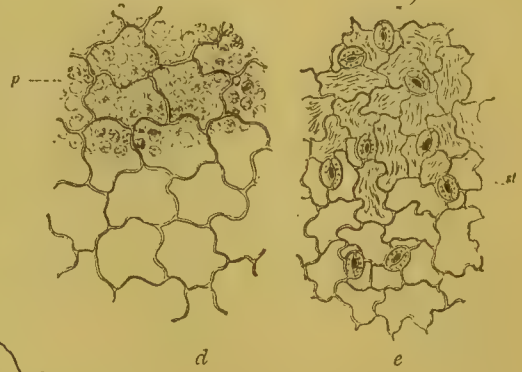
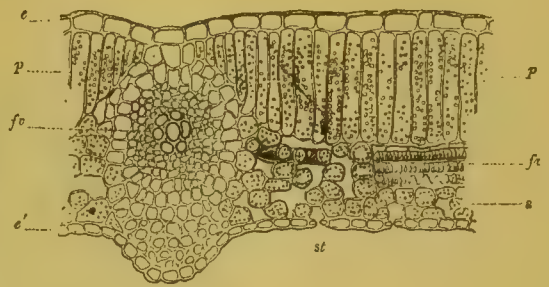
1. **Conii Folia.**—*a*, Upper leaf of *Conium maculatum*, Linné, one-fourth natural size; *á*, tip of ultimate segment of leaf, enlarged; *b*, clasping petiole of leaf, one-fourth natural size; *c*, tranverse section of leaf (after Vogl), enlarged, showing epidermis cells, (*e,é*), palisade cells (*p*), fibro-vascular bundles (*fv*), and stoma (*st*); *d*, upper epidermis of leaf (after Vogl), enlarged, showing palisade cells (*p*); *e*, lower epidermis (after Vogl), enlarged, showing stomata (*st*).
2. **Cusso.**—*A*, Flowering branch of *Brayera anthelmintica*, Kunth (after Berg and Schmidt), about one-half natural size; *B*, staminate flower, closed; *C*, same, open; *D*, pistillate flower; *E*, same, cut longitudinally; *B.C.D.E.* (after Luerssen), enlarged—*b*, outer whorl of sepals; *k*, inner whorl of sepals; *c*, corolla.
3. **Coriandri Fructus.**—*a*, English fruit of *Coriandrum sativum*, Linné; *b*, Indian fruit; *c*, English fruit, enlarged, showing wavy ridges; *d*, commissural surface of mericarp, enlarged.



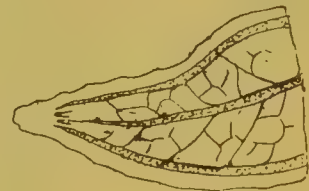
1.



1c.



2.



1d

3.



c

a

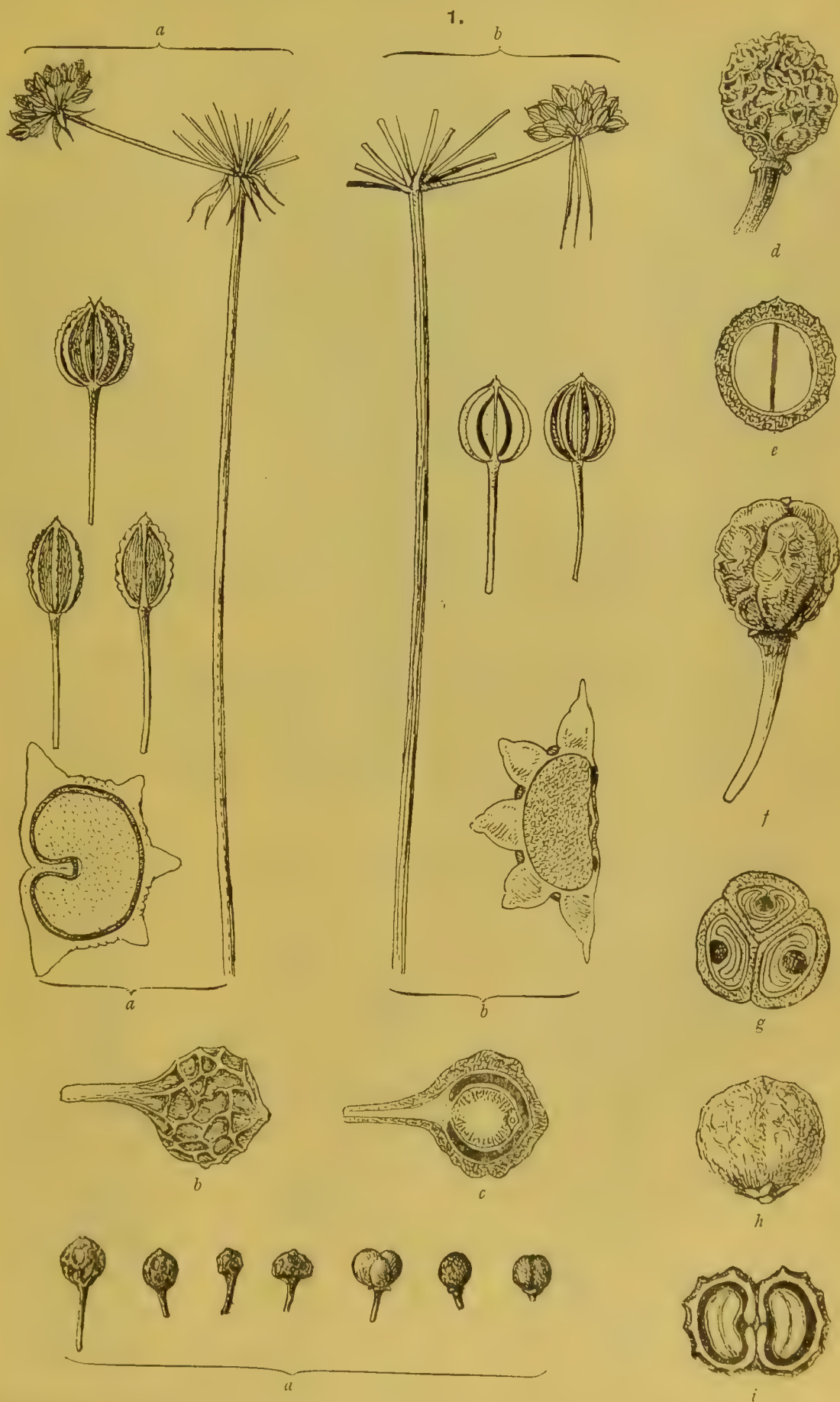
b



d

## PLATE XV.

1. **Conii Fructus.**—*a*, Fruit of *Conium maculatum*, Linné, *in situ*, with enlarged representations of an entire cremocarp, external and commisural surfaces of a single mericarp, and a transverse section of same; *b*, fruit of Fool's Parsley, *Æthusa Cynapium*, Linné, *in situ*, with enlarged representations of external and commisural surfaces of a single mericarp, and a transverse section of same, showing vittæ.
2. **Cubebæ Fructus.**—*a*, Fruits of *Piper Cubeba*, Linné; *b*, fruit, enlarged to show reticulate wrinkles; *c*, longitudinal section of fruit, enlarged, showing embryo at apex of seed and stalk-like elongation of pericarp; *d*, fruit of *Tetranthera citrata*, Nees, enlarged; *e*, transverse section of same, enlarged; *f*, fruit of *Rhamnus* sp. enlarged; *g*, transverse section of same, enlarged; *h*, fruit of *Briedalia montana*, enlarged; *i*, transverse section of same, enlarged.





## PLATE XVI.

1. **Cuspariæ Cortex.**—*a*, Inner surface of bark of *Cusparia febrifuga*, De Candolle, showing laminated structure and portion of wood attached; *b*, outer surface of bark, showing corky layer and obliquely cut edge.
2. **Digitalis Folia.**—*a*, Root leaf of *Digitalis purpurea*, one-fourth natural size, showing winged petiole with decurrent veins; *b*, stem leaf, one-fourth natural size; *c*, transverse section of leaf (after Vogl), enlarged, showing hairs (*d*, *h*) on epidermis (*e*, *é*), palisade cells (*p*), and fibro-vascular bundle (*fv*); *d*, lower epidermis (after Vogl), enlarged, showing simple (*h*) and glandular (*d*) hairs, and stomata (*st*).
3. **Dulcamara.**—Pieces of dried stem and branches of *Solanum Dulcamara*, Linné, showing hollow centre.

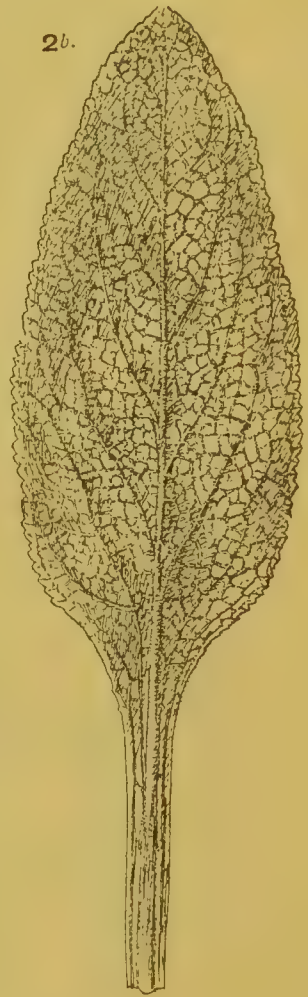
1a.



2a.



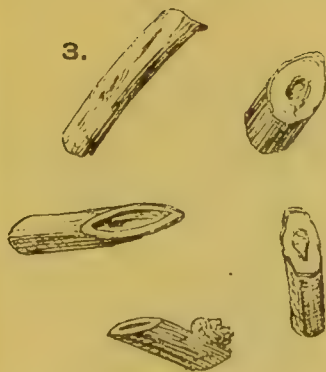
2b.



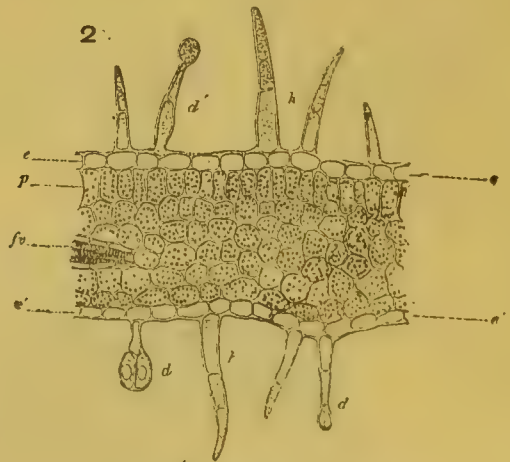
1b.



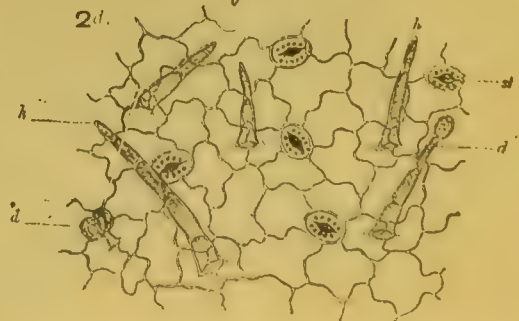
3.



2.



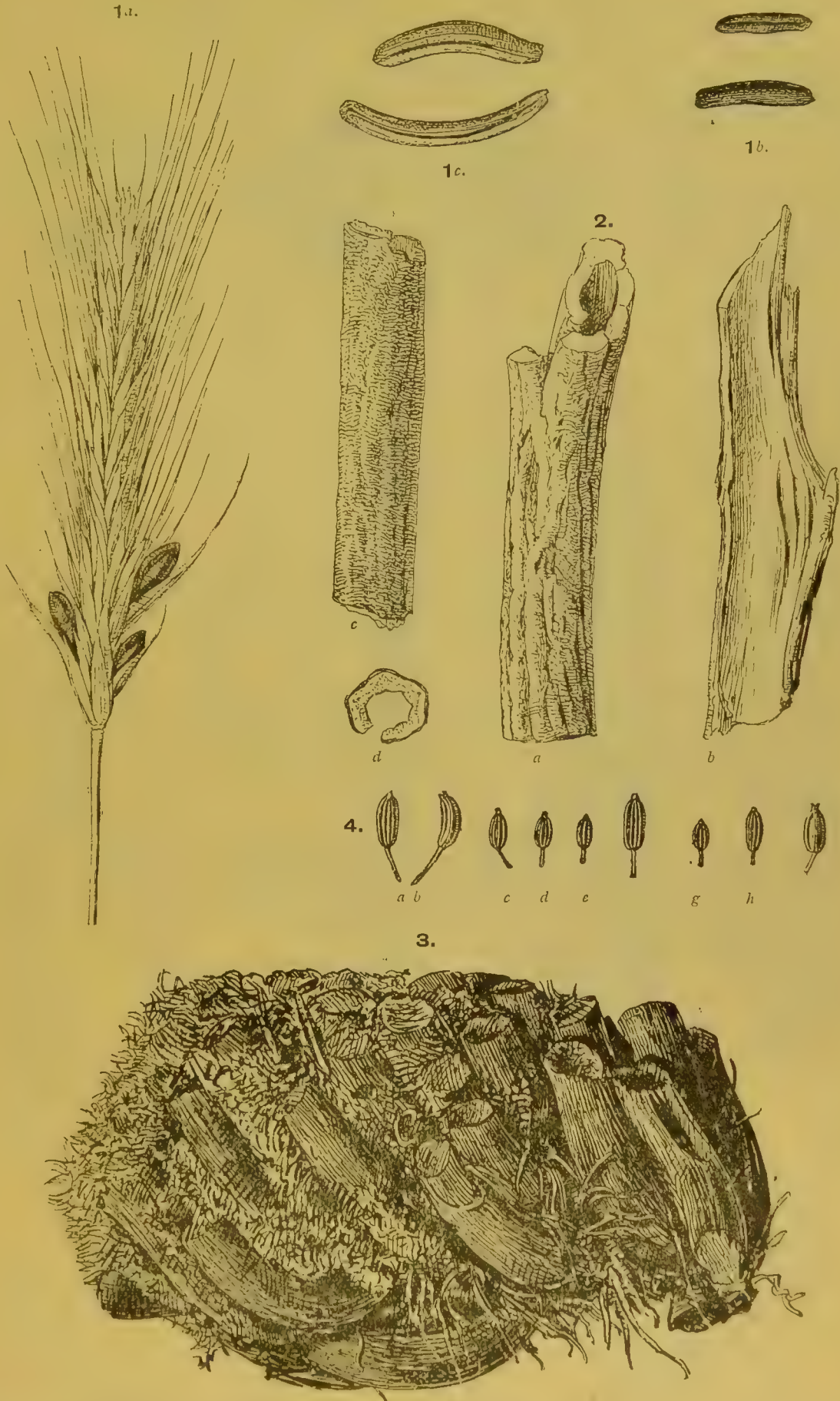
2d.



## PLATE XVII.

1. **Ergota.**—*a*, Ear of rye, *Secale cereale*, Linné, attacked by the ergot fungus, *Claviceps purpurea*, Tulasne; *b*, Russian ergot; *c*, Spanish ergot.
2. **Euonymi Cortex.**—*a*, Outer surface of root-bark of *Euonymus atropurpureus*, Jacquin, showing finely-fissured cork; *b*, inner surface of root-bark; *c*, stem-bark; *d*, transverse section of euonymus bark.
3. **Filix Mas.**—Rhizome of *Aspidium Filix-mas*, Swartz, with bases of petioles attached.
4. **Fœniculi Fructus.**—*a*, German fruit of *Fœniculum capillaceum*, Gilibert, showing prominent ridges; *b, i*, French sweet fennel; *c*, Galician; *d*, Russian; *e*, French bitter fennel; *f*, Indian; *g*, Japanese; *h*, Persian. After Umney.





## PLATE XVIII.

1. **Galla.**—*a, b*, Aleppo galls, from *Quercus infectoria*, Olivier, showing tuberculated surface; *c*, transverse section of gall.
2. **Gelsemii Radix.**—*a*, Rhizome and rootlets of *Gelsemium nitidum*, Michaux; *b*, root of same; *c*, transverse section of root, showing radiate structure; *d*, transverse section of rhizome; *e*, piece of rhizome with aerial stem attached (after Holmes).
3. **Gentianæ Radix.**—*a*, Root of *Gentiana lutea*, Linné, showing longitudinal wrinkles; *a'*, transverse section of same, enlarged; *b*, rhizome of *G. lutea*, showing bud and point of attachment of root; *b'*, transverse section of rhizome, enlarged.





## PLATE XIX.

**Glycyrrhizæ Radix.**—*a*, Root of Spanish liquorice, *Glycyrrhiza glabra*, Linné, showing transverse scars and fibrous bark; *a1*, transverse section of same, enlarged; *b*, rhizome of Spanish liquorice, showing buds; *b1*, transverse section of same, showing pith; *c*, root of Bussorah liquorice; *d*, rhizome of Bussorah liquorice; *d1*, transverse section of same.

*a*



*b*



*c*



*d*



*a1*



*b1*



*d1*

## PLATE XX.

1. **Granati Cortex.**—*a*, Outer surface of root-bark of *Punica Granatum*, Linné, showing rough surface with conchoidal depressions; *b*, inner surface of same; *c*, outer surface of stem bark, showing longitudinal furrows and bands of cork.
  
2. **Hirudo.**—*a*, Dorsal surface of speckled leech, *Sanguisuga medicinalis*, Savigny; *b*, ventral surface of same; *c*, dorsal surface of green leech, *S. officinalis*, Savigny (after Brandt and Ratzeburg).



1.



*a*

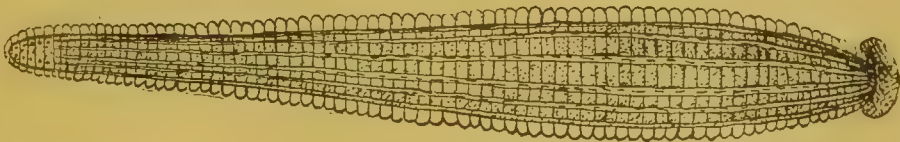


*b*

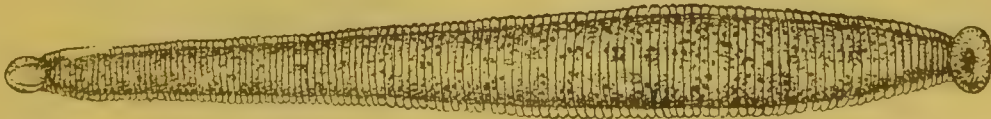


*c*

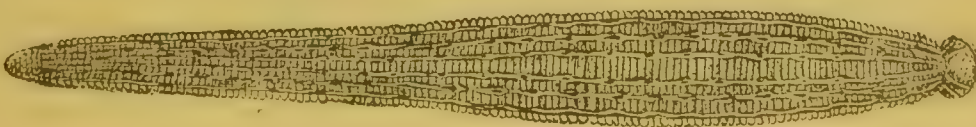
2.



*a*



*b*



*c*

## PLATE XXI.

1. **Grindelia.**—*a*, Upper part of stem of *Grindelia squarrosa*, Nuttall, showing globular flower-head; *b*, *c*, leaves of same; *d*, upper part of stem of *G. robusta*, showing conical flower-heads; *e*, leaves of same; *f*, tip of leaf, enlarged.
2. **Hamamelidis Folia.**—Under surface of leaf of *Hamamelis virginiana*, Linné, showing prominent veins, the lateral ones running direct to the margin.

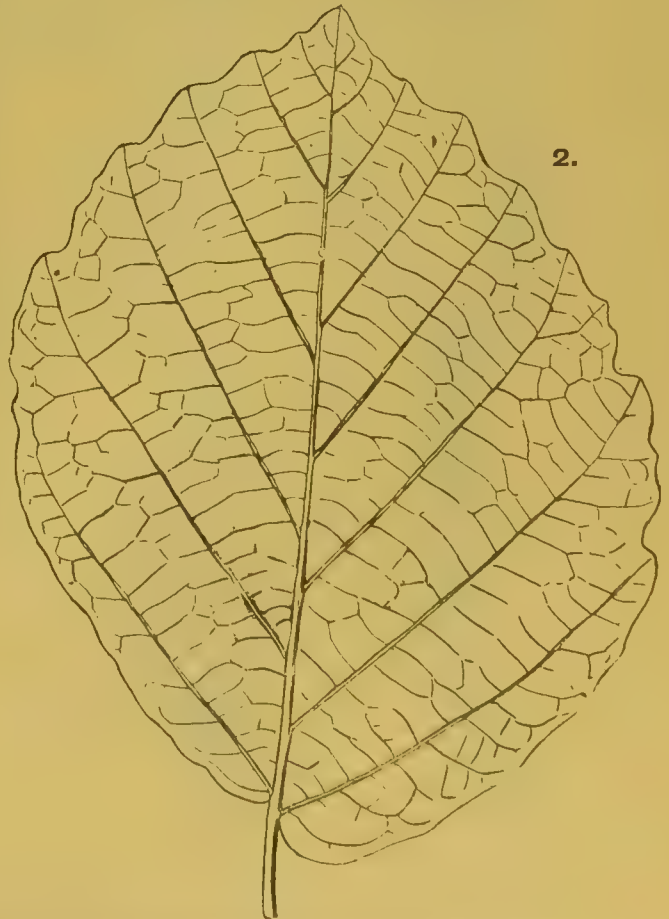
1.



1.



2.

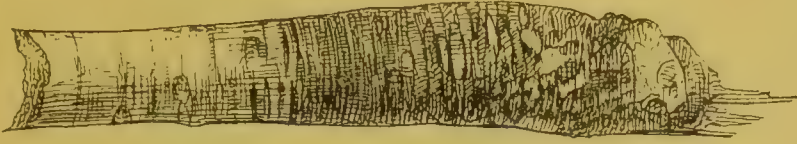




## PLATE XXII.

1. **Hamamelidis Cortex.**—*a*, Outer surface of bark of *Hamamelis virginiana*, Linné, with cork partly removed ; *b*, ditto, with cork attached ; *c*, inner surface of bark.
2. **Hemidesmi Radix.**—*a*, Root of *Hemidesmus indicus*, R. Brown, showing transverse cracks and loose cork ; *b*, ditto, showing longitudinal furrows ; *c*, transverse section of root, enlarged, showing indistinctly radiate wood.

1a.



2b.



1b.



1c.



2a.



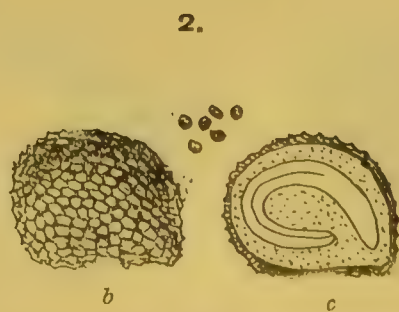
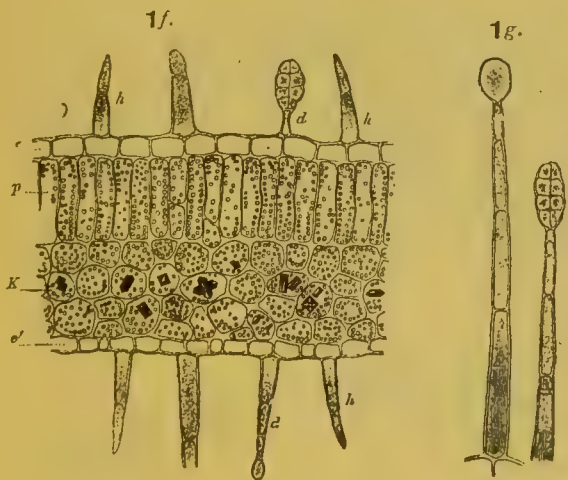
2c.



## PLATE XXIII.

1. **Hyoscyami Folia.**—*a, b*, Root leaves of *Hyoscyamus niger*, Linné, one-ninth natural size, showing sinuate-dentate outline and broad midrib; *c, d*, sessile stem leaves of same, one-ninth natural size; *f*, transverse section of leaf (after Vogl), enlarged, showing simple (*h*) and glandular (*d*) hairs, epidermal cells (*e, ê*), palisade cells (*p*), and crystal cells (*k*); *g*, glandular hairs (after Vogl), enlarged; *h*, upper epidermis of leaf (after Vogl), enlarged, showing fibro-vascular bundles (*f, v*), crystal cells (*k*), and palisade cells (*p*).
2. **Hyoscyami Semina.**—*a*, Seeds of *Hyoscyamus niger*, Linné; *b*, single seed, enlarged, showing reticulations; *c*, transverse section of seed, enlarged, showing coiled embryo.



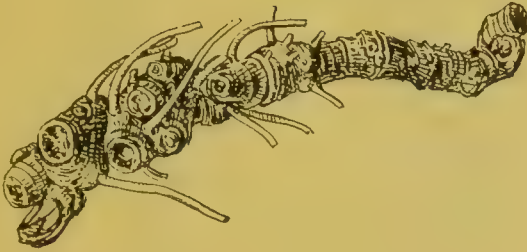


## PLATE XXIV.

1. **Hydrastis Rhizoma.**—*a*, Under surface of rhizome of *Hydrastis canadensis*, Linné, showing roots; *b*, upper surface of rhizome, showing branches, with scars of cataphyllary leaves; *c*, transverse section of rhizome, enlarged, showing thick bark and ring of narrow wood bundles surrounding a large pith.
2. **Ipecacuanhæ Radix.**—*a*, *b*, Root of Brazilian ipecacuanha, *Psychotria Ipecacuanha*, Stokes; *c*, ditto, with portion of stem attached; *d*, root of Cartagena ipecacuanha, with portion of stem attached; *e*, *f*, transverse sections of Brazilian root, enlarged; *g*, transverse section of Brazilian stem, enlarged; *h*, transverse section of Cartagena root, enlarged; *i*, transverse section of Cartagena stem, enlarged.



1a.



1b.



1c.



2a.



2e.



2b.



2g.



2f.



2c.



2h.



2d.

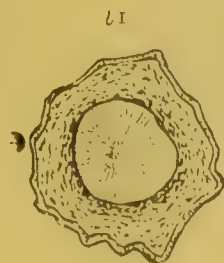
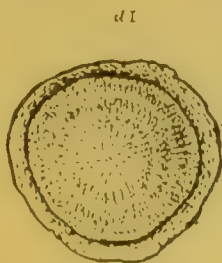


2i.



## PLATE XXV.

**Ipecacuanhæ Radix.** — False ipecacuanha roots; *a*, root of *Ionidium Ipecacuanha*; *a*1, transverse section of same, enlarged; *b*, root of *I. parviflorum*; *b*1, transverse section of same, enlarged; *c*, root of *Richardsonia brasiliensis*; *c*1, transverse section of same, enlarged; *d*, root of *Psychotria emetica*; *d*1, transverse section of same, enlarged.

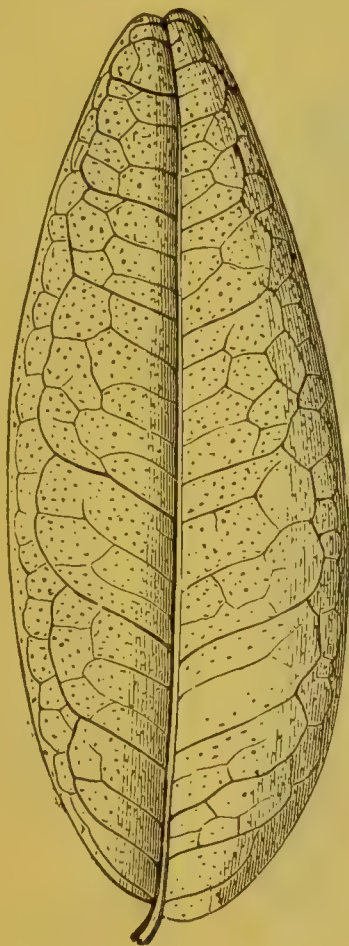


## PLATE XXVI.

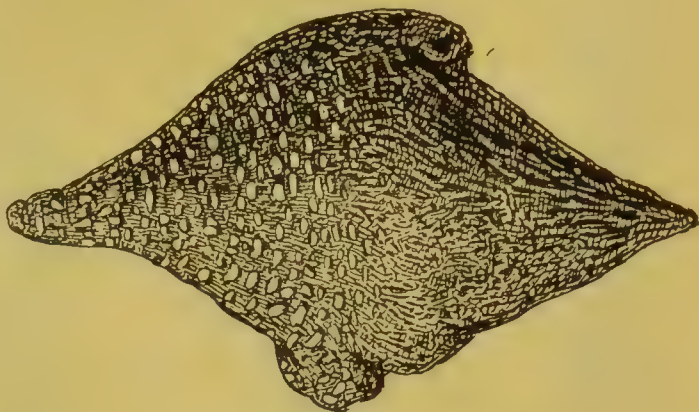
1. **Jaborandi Folia.**—Under side of leaflet of *Pilocarpus Jaborandi*, Holmes, showing short stalk, unequal base, blunt and emarginate apex.
2. **Jalapa.**—*a*, Tubercle of Vera Cruz jalap, from *Ipomœa Purga*, Hayne, showing transverse scars; *b*, Tampico jalap, from *I. simulans*, Hanbury; *c*, Orizaba or male jalap, from *I. orizabensis*, Leden; *d*, transverse section of Jamaica jalap, from *I. Purga*, Hayne.



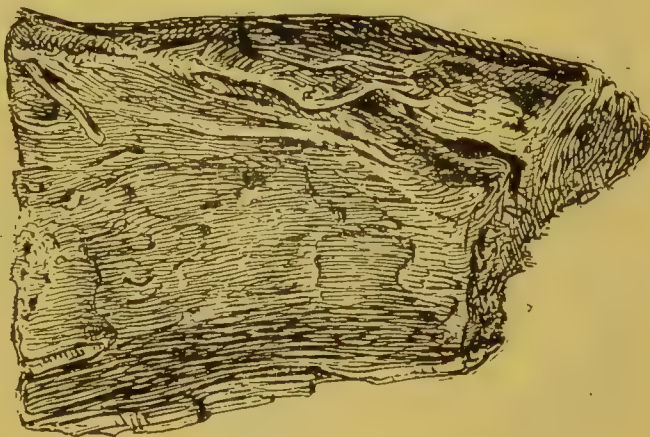
1.



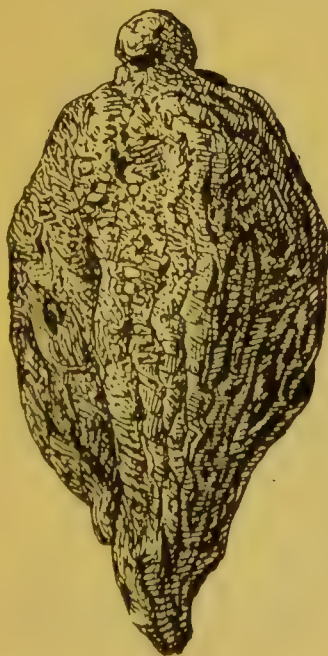
2a.



2c.



2b.

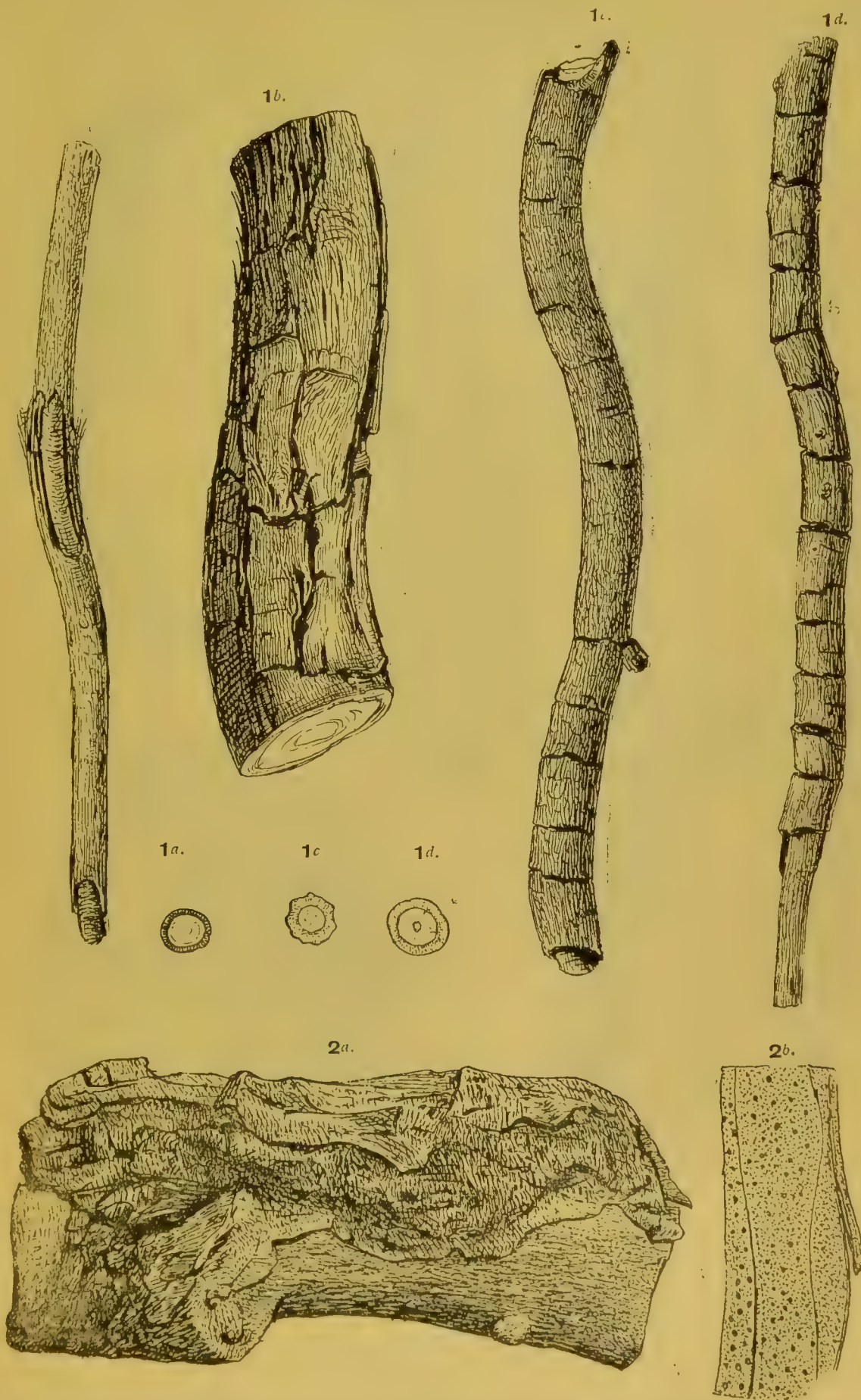


2d.



## PLATE XXVII.

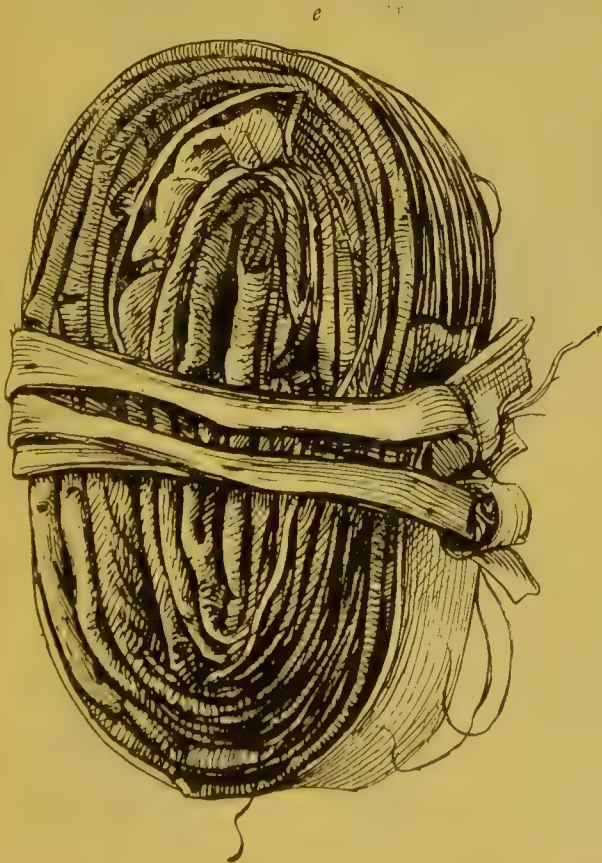
1. **Krameriae Radix.**—*a, b*, Root of Peruvian rhatany, from *Krameria triandra*, Ruiz and Pavon; *á*, transverse section of *a*; *c*, Para rhatany, from *K. argentea*, Martius; *c'*, transverse section of same; *d*, Savanilla rhatany, from *K. tomentosa*; *d'*, transverse section of same.
2. **Laricis Cortex.**—*a*, Outer surface of bark of *Larix europæa*, De Candolle, with part of cork removed; *b*, transverse section of same, enlarged,





## PLATE XXVIII.

**Mezerei Cortex.**—*a*, Bark of *Daphne mezereum*, Linné; *b*, twig of same, showing leaf-buds; *c*, bark of *D. laureola*, Linné; *d*, stem of same, showing scars crowded together at intervals; *e*, original bundle of *D. mezereum*, as met with in commerce.



## PLATE XXIX.

1. **Lupulus.**—*a*, Strobile of *Humulus lupulus*, Linné; *b*, bract, enfolding fruit and showing glands; *c*, fruit, showing glands, enlarged. After Tschirch.
2. **Lupulinum.**—Glands from strobiles of *Humulus lupulus*, Linné ( $\times 125$ ). After Moeller.
3. **Myristica.**—*a*, *b*, Seeds of *Myristica fragrans*, Houttuyn, with mace *in situ*; *c*, transverse section of nutmeg, showing ruminated albumin; *d*, nutmeg, with mace and part of testa removed.
4. **Nux Vomica.**—*a*, Ceylon seed of *Strychnos nux vomica*, Linné; *b*, ditto, showing ridge; *c*, Madras seed; *d*, ditto, showing ridge; *e*, seed of *S. ignatii*, Bergius; *f*, transverse section of *a*; *g*, Ceylon seed (*a*), split in half, showing embryo; *h*, ripe fruit of *S. nux vomica*, reduced to about one-half its natural size, showing seeds imbedded in pulp.





## PLATE XXX.

Opium.—*A*, Constantinople opium, from *Papaver somniferum*, Linné, showing regular arrangement of poppy leaf enveloping the mass; *B*, Smyrna opium, showing irregular arrangement of poppy leaf.





*A*

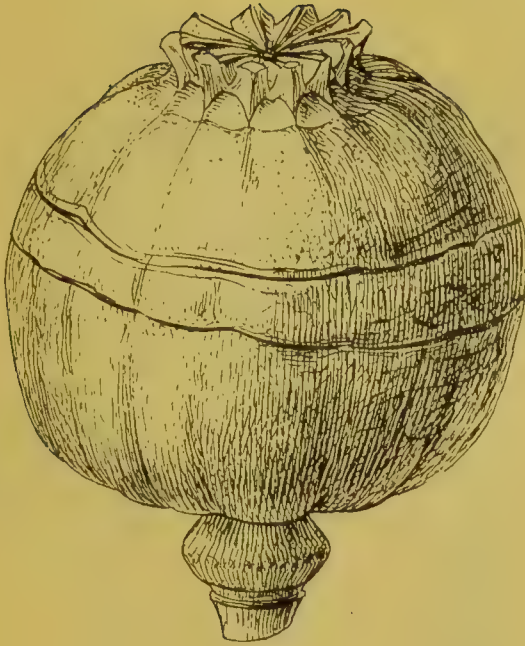


*B*

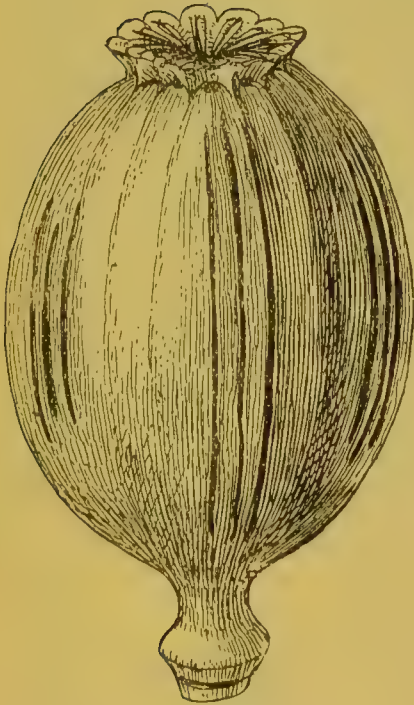


## PLATE XXXI.

1. **Papaveris Capsulæ.**—*a*, Capsule of *Papaver somniferum*, Linné, showing Turkish method of incision for obtaining opium ; *b*, poppy capsule, showing Indian method of incision.
2. **Pareiræ Radix.**—*a*, Root of *Chondrodendron tomentosum*, Ruiz and Pavon, showing longitudinal furrows and transverse ridges and fissures ; *b*, transverse section of root, showing more or less concentric zones of wedge-shaped wood bundles.



1a.



1.



2b.



2a.

## PLATE XXXII.

1. **Pareiræ Radix.**—Substitutes for true pareira. *a*, Stem of *Chondrodendron tomentosum*, Ruiz and Pavon, showing warty surface; *a*<sub>1</sub>, transverse section of same, showing small pith; *b*, Bahia pareira root, from unknown menispermaceous plant; *b*<sub>1</sub>, transverse section of same. See also Cissampelos.

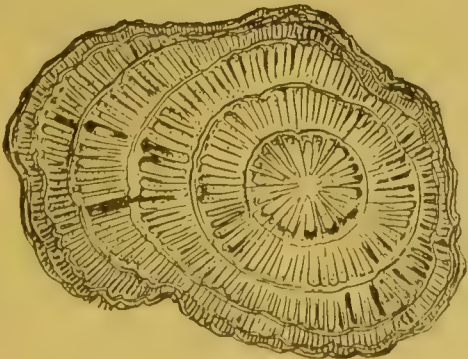




a



b



a1



b1

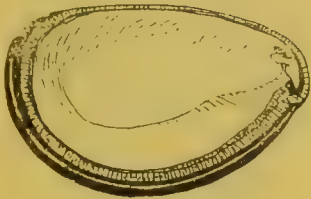
## PLATE XXXIII.

1. **Physostigmatis Semina.**—*a*, Seed of *Physostigma venenosum*, Balfour, showing hilum and traces of funiculus; *b*, same, split longitudinally, showing plumule and radicle at base; *c*, transverse section of *a*; *d*, seed of *P. cylindrospermum*, Holmes, showing short hilum; *e*, same, split longitudinally.
2. **Pimenta.**—*a*, Red pimento, from *Pimenta officinalis*, Lindley, showing apex and base of fruit, and seed; *b*, transverse section of fruit, enlarged; *c*, grey pimento, from *P. acris*, showing apex and base of fruit, and seed.
3. **Piper Nigrum.**—*a*, Fruits of *Piper nigrum*, Linné, and transverse section; *b*, white pepper, showing apex, base, section, and side view of fruit.
4. **Podophylli Rhizoma.**—*a*, Upper surface of forked rhizome of *Podophyllum peltatum*, Linné, showing stem and leaf scars; *b*, under surface of rhizome, showing roots and root scars; *c*, transverse section of rhizome; *d*, same, enlarged, showing fibro-vascular bundles; *e*, section through rooting portion of rhizome; *f*, same, enlarged.





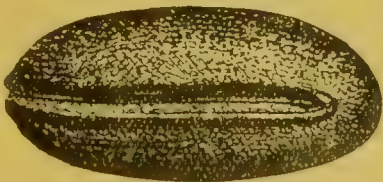
1a.



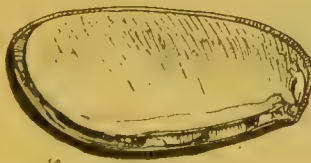
1b.



1c.



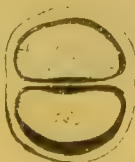
1d.



1e.



2a.



2b.



4a.

4.



4.



4.



4.



3a.



3b.



2.

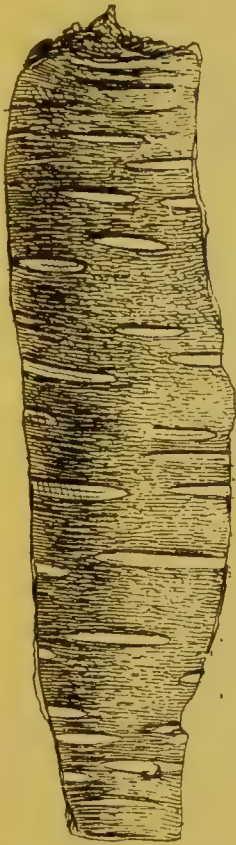


4.



## PLATE XXXIV.

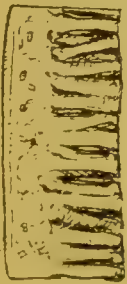
1. **Pruni Virginianæ Cortex.**—*a*, Old bark of *Prunus serotina*, Ehrhart, showing scars corresponding to lenticels; *b*, young bark of same, showing cork with transverse lenticels; *c*, transverse section of bark, enlarged; *d*, inner surface of bark, showing irregular reticulations.
2. **Pyrethri Radix.**—*a*, Root of *Anacyclus Pyrethrum*, De Candolle, showing longitudinal wrinkles; *b*, transverse section of same, showing radiate structure of wood; *c*, branched rootstock of same.



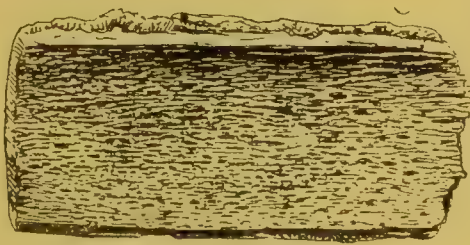
1a.



1b.



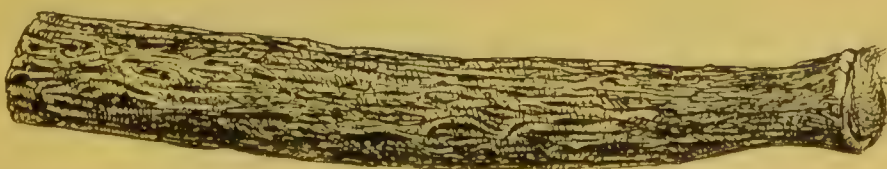
1c.



1d.



2c.



2a.



2b.

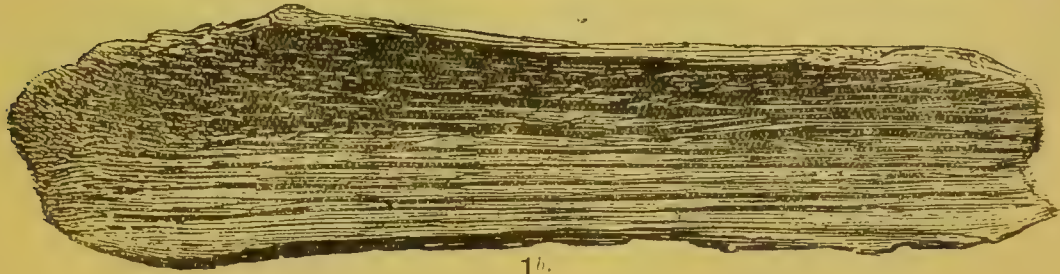
## PLATE XXXV.

1. **Quercus Cortex.**—*a*, Outer surface of bark of *Quercus robur*, Linné, showing cork marked with transverse lenticels; *b*, inner surface of bark, showing longitudinal striations.
2. **Quillaia Cortex.**—*a*, Outer surface of bark of *Quillaia saponaria*, Molina, showing longitudinal striations, and streaks where the outer portion of bark has been imperfectly removed; *b*, inner surface of bark, showing laminated fracture.





1a.



1b.



2i

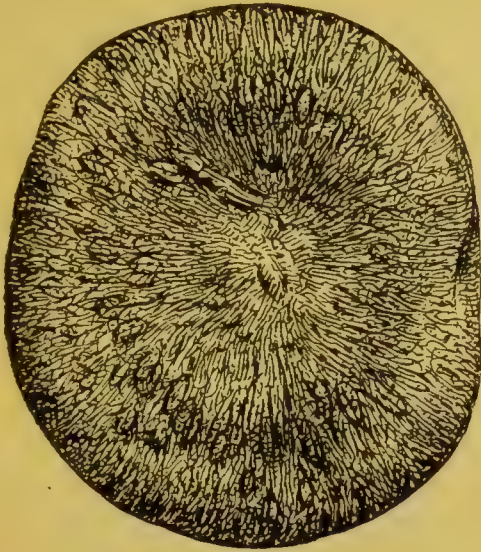


2j.

## PLATE XXXVI.

**Rhei Radix.**—*a*, End of sun-dried piece of East Indian root of *Rheum palmatum*, Linné, var. *tanguticum*, Prejevalsky; *b*, end of kiln-dried piece of rhubarb root, showing shrunken centre; *c*, flat piece of rhubarb, rhizome, showing reticulated markings; *d*, rounded piece of rhubarb, showing perforation and sliced surface.

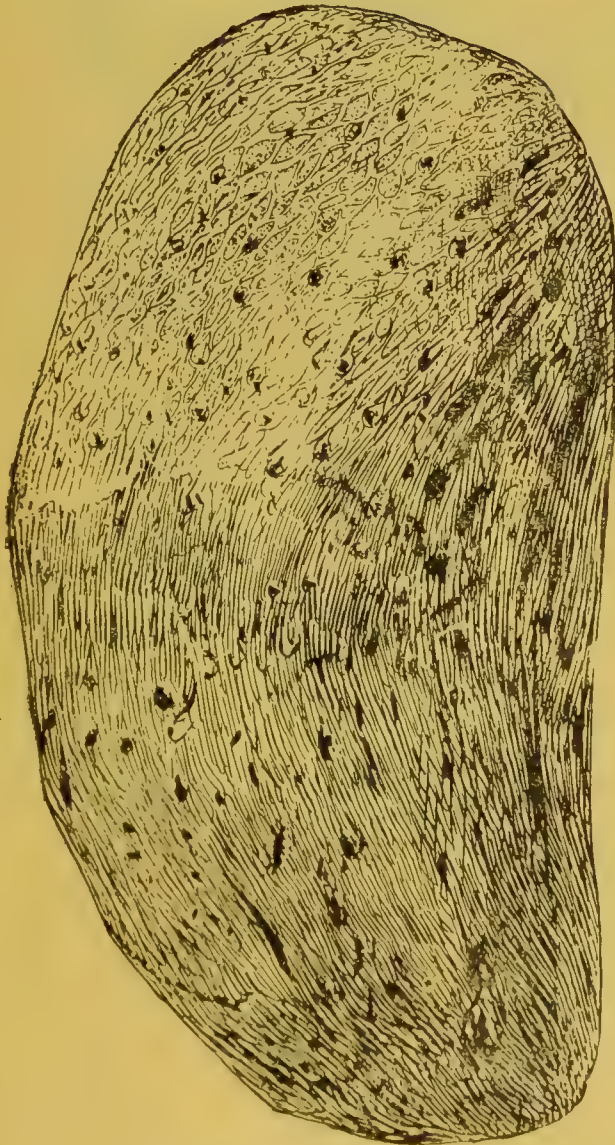




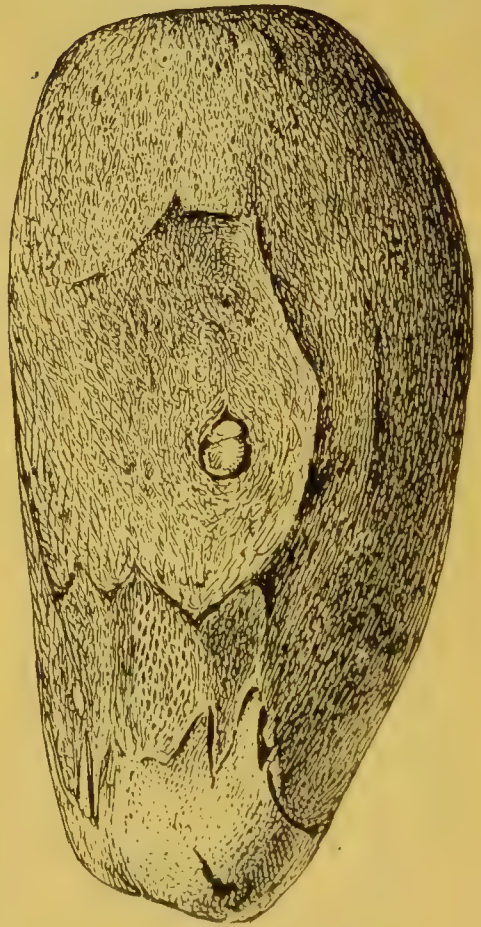
*a*



*b*



*c*



*d*



## PLATE XXXVII.

**Sassafras Radix.**—*a*, Piece of large root of *Sassafras officinale*, T. Nees and Ebermaier, showing rough bark; *b*, piece of smaller root; *c*, transverse section of *a*, showing annual rings, traversed by fine medullary rays and containing large vessels.



## PLATE XXXVIII.

1. **Sarsæ Radix.**—Original bundle of root of *Smilax ornata*, Hooker filius, reduced to one-ninth natural size.
2. **Scammoniæ Radix.**—*a*, Root of *Convolvulus scammonia*, Linné, spirally twisted and longitudinally furrowed, reduced to one fourth natural size; *b*, transverse section of same, natural size, showing numerous irregularly arranged wood bundles, surrounded by parenchymatous tissue containing resin cells.





## PLATE XXXIX.

1. **Sabinæ Cacumina.**—*a*, Fruiting twig of *Juniperus Sabina*, Linné: *b*, male catkin, enlarged; *c*, twig with female flower, enlarged.
2. **Scoparii Cacumina.**—*a*, Dried tops of *Cytisus Scoparius*, Link, reduced to one-fourth natural size; *b*, branch with portion of stem, natural size.
3. **Senegæ Radix.**—Root of *Polygala Senega*, Linné, showing keel and direction of branches.



1a.



1b.



1c.

3.



2a.



2b.



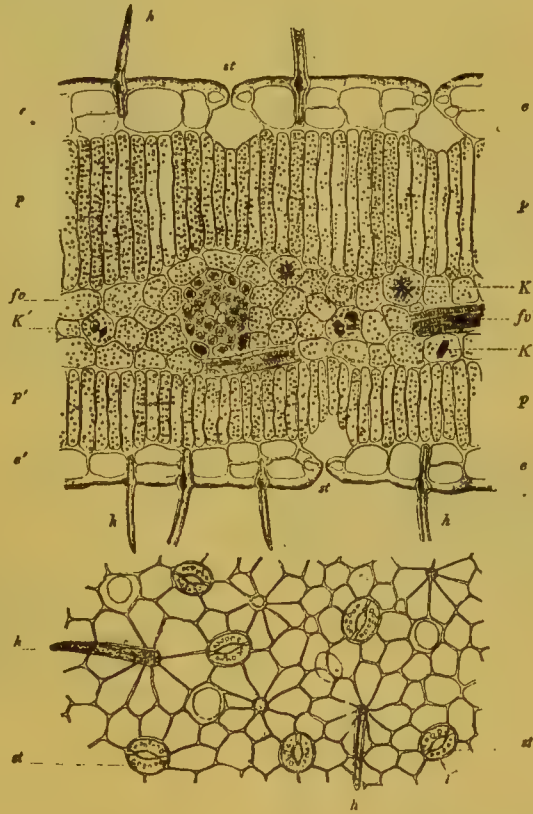
## PLATE XL.

1. **Senna Alexandrina.**—*a*, Typical leaflets of *Cassia acutifolia*, Delile, showing symmetrical lanceolate or oval-lanceolate shape, and distinct veins on under surface; *b*, transverse section of senna leaf (after Vogl), enlarged, showing hairs (*h*), epidermal cells (*e*, *é*), stomata (*st*), palisade cells (*p*), crystal cells (*k*), fibro-vascula bundles (*fv*); *c*, lower epidermis of senna leaf (after Vogl), showing hairs (*h*) and stomata (*st*).
2. **Senna Indica.**—Typical leaflets of *Cassia angustifolia*, Vahl, showing unequal base and elongate-lanceolate shape.



1a.

1b.



1c



## PLATE XLI.

1. **Serpentaria Rhizoma.**—*a, b*, Rhizomes, with roots of *Aristolochia reticulata*, Nuttall; *c, d*, rhizomes, with roots, of *A. Serpentaria*, Linné.
2. **Sinapis Nigræ Semina.**—*A*, Seed of *Brassica sinapioides*, Roth, enlarged. *B*, transverse section of same ( $\times 65$ ), showing the two cotyledons (4, 4) and radicle (5); *C*, transverse section of part of seed ( $\times 190$ ), showing epidermal cells in which the mucilage occurs. After Berg.

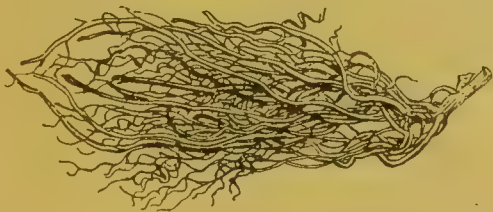




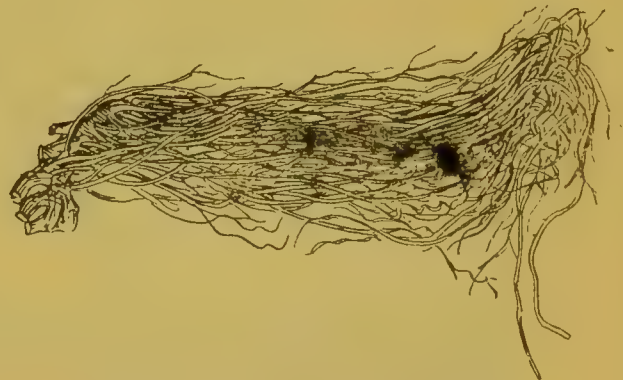
1a.



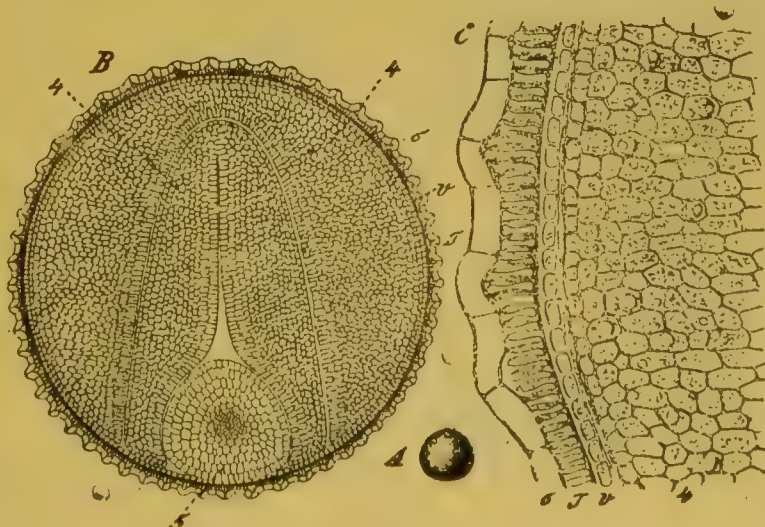
1b.



1c.



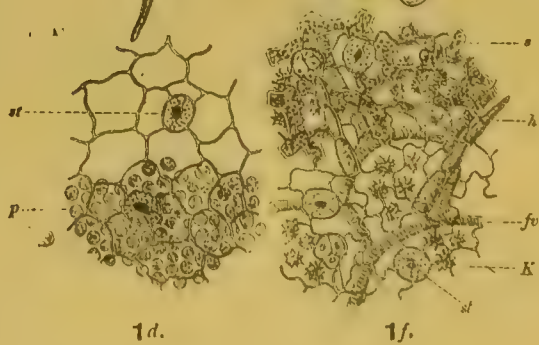
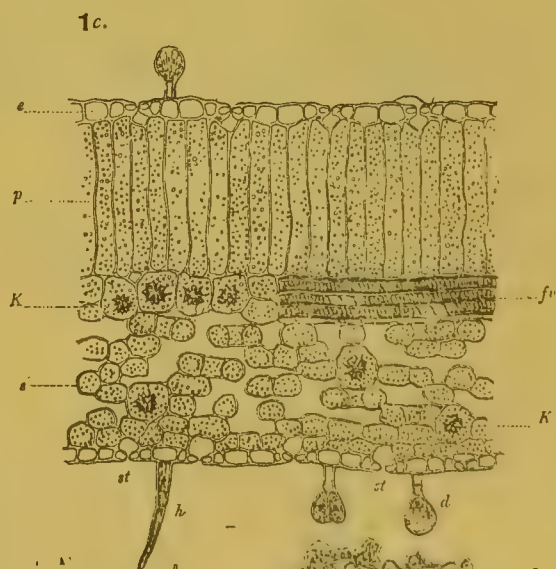
1d.



2.

## PLATE XLII.

1. **Stramonii Folia.**—*a, b*, Leaves of *Datura Stramonium*, Linné, one-fourth natural size; *c*, transverse section of leaf (after Vogl), enlarged, showing simple (*h*) and glandular (*d*) hairs, epidermal cells (*e*), palisade cells (*p*), crystal cells (*k*), fibro-vascular bundles (*fv*), and spongy parenchyma (*s*); *d*, upper epidermis of stramonium leaf (after Vogl), enlarged, showing stoma (*st*) and palisade cells (*p*); *f*, lower epidermis of leaf (after Vogl), enlarged, showing stomata (*st*), fibro-vascular bundles (*fv*), crystal cells (*k*), hairs (*h*), and spongy parenchyma (*s*).
2. **Stramonii Semina.**—*a*, Seeds of *Datura Stramonium*, Linné; *b*, single seed, enlarged, showing reticulate depressions; *c*, transverse section of seed, enlarged; *d*, longitudinal section of seed, enlarged, showing curved embryo.

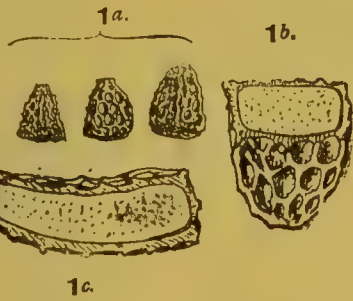




## PLATE XLIII.

1. **Staphisagriæ Semina.**—*a*, Seeds of *Delphinium Staphisagria*, Linné, showing roughly pitted surface; *b*, transverse section of seed, enlarged; *c*, longitudinal section of seed, enlarged.
2. **Strophanthi Semina.**—*a*, Typical forms of seeds of *Strophanthus Kombé*, Oliver, showing appressed hairs; *b*, transverse section of seed, enlarged.
3. **Sumbul Radix.**—Transverse slice of root of *Ferula Sumbul*, Hooker.filius, showing transversely wrinkled cork and fibrous spongy interior, with whitish spots.
4. **Uvæ Ursi Folia.**—*a*, *b*, *d*, *e*, Upper surface of leaves of *Arctostaphylos Uva-ursi*, Sprengel, showing depressed reticulations; *c*, *f*, under surface of leaves, showing faint reticulate markings.

3.



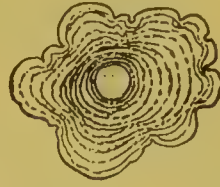
## PLATE XLIV.

1. **Taraxaci Radix.**—*a*, Root of *Taraxacum officinale*, Wiggers, showing a portion of rhizome at top ; *b*, transverse section of same, showing a small porous central wood, surrounded by a very thick cortex, in which are numerous irregular concentric rings of laticiferous vessels.
2. **Valerianæ Rhizoma.**—*a*, Rhizome and rootlets of *Valeriana officinalis*, Linné ; *b*, section of rhizome.





1a



1b



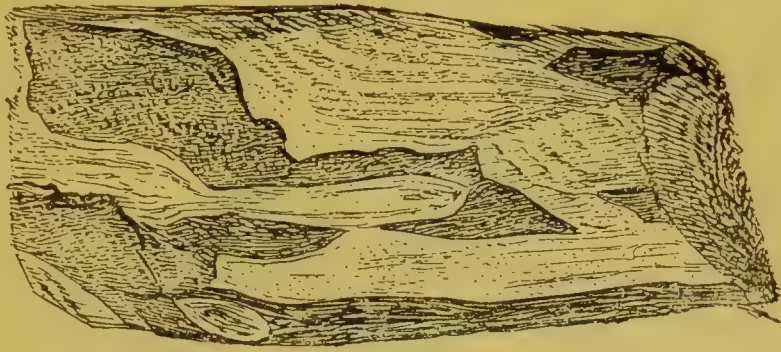
2a.



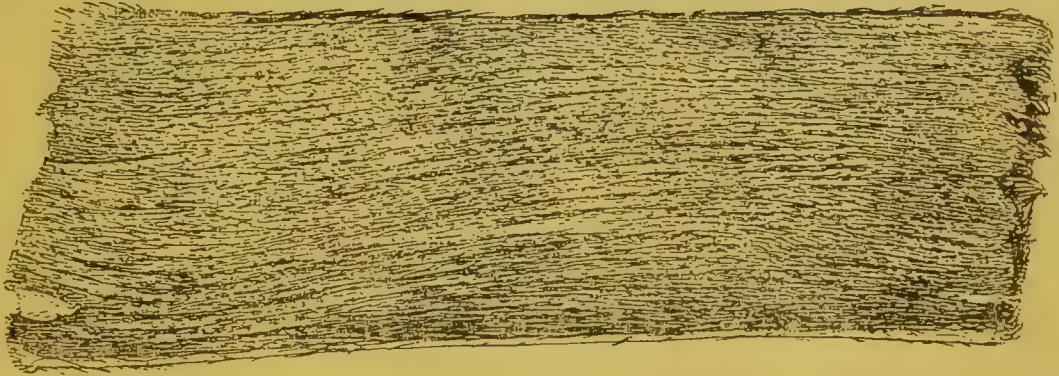
2'

## PLATE XLV.

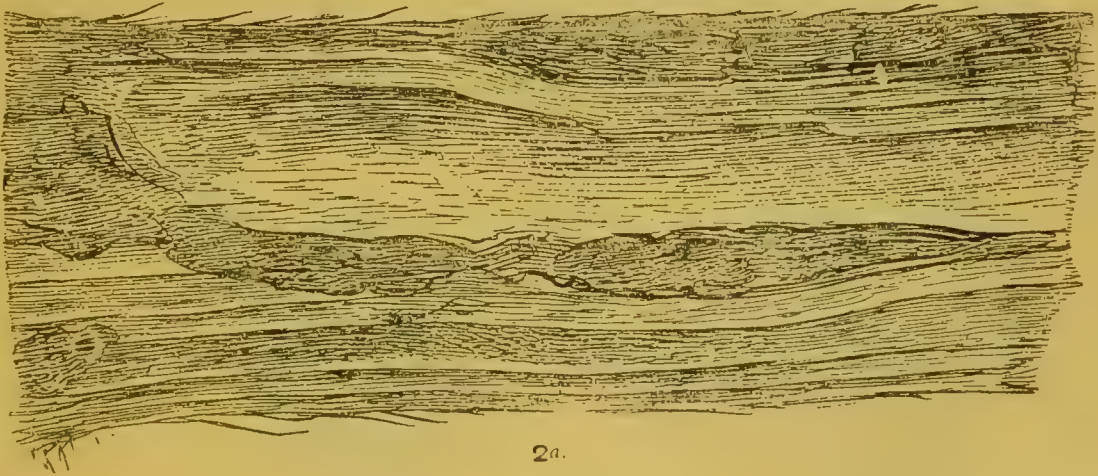
1. **Ulmi Cortex.**—*a*, Outer surface of bark of *Ulmus campestris*, Linné, showing patches of cork; *b*, inner surface of bark, showing striations.
2. **Ulmi Fulvæ Cortex.**—*a*, Outer surface of bark of *Ulmus fulva*, Michaux, showing patches of cork and longitudinal striations; *b*, inner surface of bark, showing striations.



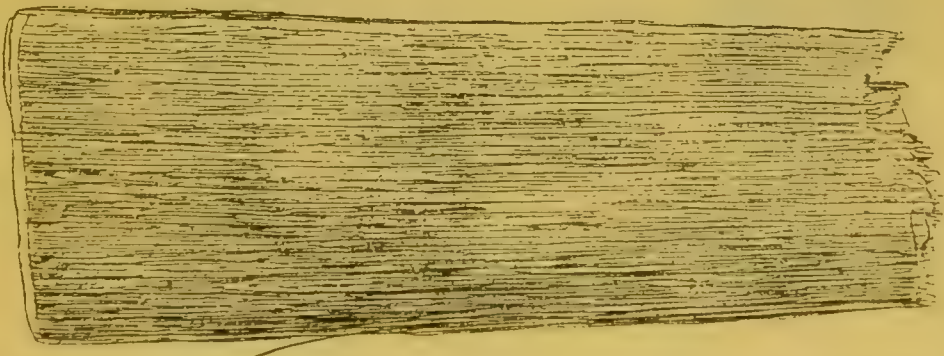
1a.



1b.



2a.

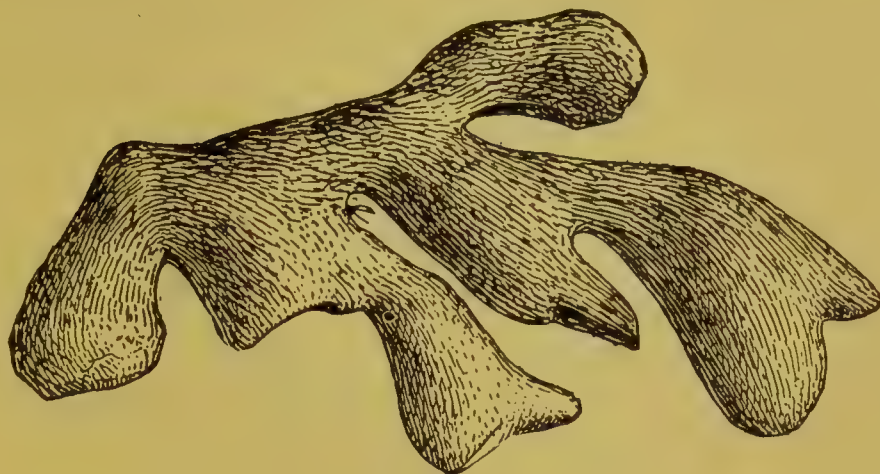


2b.



## PLATE XLVI.

**Zingiber.**—*a*, Rhizome of Jamaica ginger, from *Zingiber officinale*, Roscoe, showing long branches; *b*, Cochin ginger, showing short branches; *c*, African ginger, showing patches of wrinkled cork on ventral and dorsal surfaces.



a



b



c





# INDEX.

Official Latin names of drugs and preparations in heavy type, thus: **Acaciæ Cortex**.

Botanical and zoological names in italics, thus: *Abies balsamea*.

Preparations indexed under their official names in Latin, and also under the English names of the drugs from which they are derived.

Drugs in "Atlas" indexed under official Latin names, the pages where illustrations appear being indicated by figures followed by abbreviation "(pl.)."

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